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# A SYNOPSIS OF THE SPECIES OF AFRICAN CULICIDAE, OTHER THAN ANOPHELES.

By F. W. Edwards, B.A., F.E.S.

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Little is needed by way of introduction, beyond the statement that this paper is really a continuation of a previous one ("The African Species of *Culex* and allied Genera," Bull. Ent. Res., Oct. 1911, pp. 241–268). In the present paper a complete synopsis is given of all the African species, with the exception of some of those already tabulated and of the genus *Anopheles* and its sub-divisions. Through the kindness of Prof. R. Newstead, the author has now been able to examine the types in the collection of the Liverpool School of Tropical Medicine, so that the number of undetermined species has been considerably reduced, and all have now been accounted for except those given as doubtful in the paper referred to.

The classification of Lt.-Col. A. Alcock has been adhered to, except that *Dixa* has been admitted, forming a third sub-family. In this the writer is following the expressed opinion of Prof. S. W. Williston. The names adopted for the tribes of the Culicinae are those used by Messrs. Dyar and Knab, while, in agreement with Lt.-Col. Alcock, the Megarhinini have been retained as a distinct tribe. So far as possible, full generic synonymy has been given, but synonyms of the species, unless determined by the author, have as a rule been omitted.

It must not be supposed that anything like finality is claimed for the conclusions expressed here. Many questions require considerably more study, while others must apparently always be matters of personal opinion. The examination of more material has necessitated the partial modification of views previously given, while some errors in the author's previous paper on the subject have come to light and are here corrected. Doubtless some still remain.

Mr. H. F. Carter has very kindly lent me a paper published by G. F. Leicester in 1908, which he had unearthed. This has apparently been completely overlooked; it contains descriptions of a large number of species and genera, some of which are referred to later in this paper.

## Sub-family 1. CULICINAE.

Proboscis elongated; palpi frequently elongated in one or both sexes, but straight when short; wings and legs scaly, and except in some species of *Anopheles*, the thorax and abdomen also.

This sub-family includes all the true mosquitos, and is co-extensive with the family Culicidae as defined by Theobald and others. Although the proboscis is always elongate (usually about the length of the abdomen), it must not be upposed that all the species are blood-suckers—the structure of the proboscis indeed is sometimes such as to exclude the possibility of the blood-sucking habit

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being developed, while other species which probably could suck blood do not do so; others only do it occasionally, and the males never. Many feed on plant-juices in the adult stage, while one genus (*Harpagomyia*) is myrmecophilous.

The known species of this sub-family are far more numerous than those of the other two together, and they fall into three or four fairly well-marked tribes. Some authors go much further than this and divide the mosquitos into ten or eleven sub-families, while it has even been proposed to raise one genus (*Anopheles*) to family rank. The tendency seems to be for the group which would formerly (say fifteen years ago) have been regarded as a genus, to become a sub-family, while the species become genera, and varieties—individuals almost—species. The present writer follows Lt.-Col. A. Alcock in recognising four tribes of the sub-family CULICINAE. For these it seems better to retain the names of the oldest genera rather than to coin new terms, and hence these tribes are here spoken of as—

1. ANOPHELINI.
2. MEGARHININI.
3. CULICINI.
4. SABETHINI.

The great majority of the species belong to the CULICINI, the other three tribes being represented each by a single genus in the African region. The first of these tribes is not dealt with in the present paper.

## Tribe **Megarhinini.**

Proboscis with the apical half much thinner than the basal, and bent downwards at an angle with it. Scutellum evenly rounded. Wings long and narrow; fork-cells both very short, but the first much shorter than the second. Wing-margin indented just before the termination of the posterior branch of the fifth longitudinal vein, and with a small V-shaped thickening of the membrane opposite this indentation. Large species, completely clothed with flat, more or less metallic scales, usually blue or green. Larvae predaceous; adults not blood-suckers.

Dyar and Knab place these insects in the CULCINI, and consider them to be related to *Psorophora* and its allies. Both groups agree in having predaceous larvae, and in the head of the imago being provided with a distinct neck, but these characters are very likely not indicative of relationship, and so it is considered better to treat *Megarhinus* and *Toxorhynchites* as forming a separate group. The predaceous habit of the larvae, with its corresponding modifications of structure, has been developed several times independently.

### Genus TOXORHYNCHITES, Theo.

Mon. Cul. I, p. 244 (1901).

*Worcesteria*, Banks, Philipp. J. Sci. I, p. 779 (1906).

*Teromyia*, Leicester, Stud. Inst. Med. Res., Fed. Malay States, III, p. 49 (1908).

The name of this genus was first published by Dr. L. O. Howard in 1901 ("Mosquitoes," pp. 154, 155, 235, 240), who figured the North American

*Megarhinus rutilus* as *Toxorhynchites rutilus*, making his figure from a female which happened to have the palpi broken. Accordingly some have said that *M. rutilus* must be taken as the type of the genus *Toxorhynchites*, which in that case becomes a synonym of *Megarhinus*. But (1) Howard expressly stated that he had borrowed the name from proof-sheets of Theobald's monograph; (2) he said nothing to indicate that he wished to regard *M. rutilus* as the type species, while Theobald named *T. brevipalpis* as the type; (3) although he included *Toxorhynchites* in a table of genera he gave no detailed description of it. Theobald's monograph was published in November, 1901.

*Table of Species.*

1. Abdomen shining orange; third hind tarsal joint white at base*; claspers of genitalia with a long terminal spine ... ... 1. *lutescens*.
   Abdomen metallic blue or violet; second hind tarsal joint* broadly white at base ... ... ... ... ... ... ... ... 2.
2. Abdomen mostly blue; second tarsal joint of middle legs, sometimes also of fore legs, white at the base ... ... ... 2. *brevipalpis*.
   Abdomen violet; second *and third* tarsal joints of mid legs entirely white ... ... ... ... ... ... ... 3. *phytophagus*.

1. **T. lutescens**, Theo. (*Megarhinus*), Mon. Cul. I, p. 233 (1901).
   Known only from a single male.
   S. Rhodesia.

2. **T. brevipalpis**, Theo., Mon. Cul. I, p. 245 (1901).
   *Toxorhynchites marshalli*, Theo., Mon. Cul. III, p. 121 (1903).
   *Toxorhynchites conradti*, Grünb., D. ent. Zs. p. 405 (1907).

The metatarsi usually have a narrow white ring at the base, but both this and the broad ring on the second tarsal joint are sometimes incomplete dorsally. Usually the front tarsi are entirely dark, but there is sometimes a white ring on the second joint.

Sierra Leone; Ashanti; N. and S. Nigeria: N. Kamerun; Congo; Uganda; British Central Africa; S. Rhodesia; Natal.

3. **T. phytophagus**, Theo. (*phytophygus*), Mon. Cul. V, p. 102 (1910).
   Ashanti.

## Tribe Culicini.

Thorax more or less rounded; metanotum without bristles; scutellum more or less distinctly trilobed. Larvae with air-tube and median ventral brush on anal segment (after the first stage).

This tribe includes the old genera *Culex* and *Aëdes*, which were defined as having long and short palpi respectively in the male. Most authors have used this character for the primary division of the group, a division which was adopted by the writer (Bull. Ent. Res. Oct. 1911, p. 242). Messrs. Dyar and Knab, however, owing to their exhaustive study of the larval characters of the North

* The metatarsus is reckoned as the first joint.

American species, arrived at the conclusion that the length of the palpi is only of minor importance, and that long (or, as they consider, short) male palpi have been developed independently in different groups. After examining all the material in the British Museum in the light of these views—which I much regret I had not done before publishing any synoptic work—I feel bound to agree with the American authors. They, however, go further, and refuse to recognise even generic value in the differences of the palpi, since in most cases these are confined to one sex. Although there is a great deal to be said for this view, it has not been followed in the present paper, and hence it should be remembered that some groups which are here given generic rank, would by some authors be regarded only as subgenera, even if recognised at all. Scale characters have practically been discarded as of value for generic definition, though it is true that groups of species frequently show the same type of ornamentation in all their members.

Coquillett (Science, xxiii, p. 312, 1906) divided the old genus *Culex* into two groups, according to whether the claws are simple or toothed in the female, and whether the eggs are laid singly or in masses. These characters are in most cases correlated, and the mode of egg-laying is correlated with a definite structure of the abdomen. No doubt there are a few forms which would be difficult to place, but by far the larger number of Culicini fall into one of two groups, which seem to be quite natural :—

(1.) *Aëdes* group. Eggs laid singly ; last segment of female abdomen narrow, usually completely retractile into the penultimate ; claws of female, at least on the four anterior legs, nearly always toothed. Genera : *Mucidus*, *Psorophora*, *Janthinosoma*, *Ochlerotatus*, *Stegomyia*, *Aëdes*, etc.

(2.) *Culex* group. Eggs laid in masses ; last segment of female abdomen broad, immovable ; claws of female *never* toothed. Genera : *Culex*, *Taeniorhynchus*, *Aëdomyia*, *Theobaldia*, *Uranotaenia*, etc.

This division of the tribe is much more natural than one based on the length of the palpi ; it will be seen that forms with short male palpi are included in both groups.

*Table of Genera.*

1. Claws of female toothed ... ... ... ... ... ... 2.
   Claws of female simple ... ... ... ... ... ... 5.
2. Posterior cross-vein slightly beyond mid cross-vein ; legs shaggily scaled ; female palpi half as long as proboscis ... Mucidus, p. 6.
   Posterior cross-vein before mid cross-vein ; legs not shaggily scaled, female palpi not half as long as proboscis ... ... 3.
3. Male palpi with two apparent joints ; thorax bright yellow at the sides ... ... ... ... ... ... Banksinella, p. 6.
   Male palpi with three apparent joints ; thorax not bright yellow at sides ... ... ... ... ... ... ... ... 4.
4. Last two joints of male palpi thin, about equal in length ; black and white species ; head all flat-scaled ... ... Stegomyia, p. 7.
   Last two joints of male palpi more or less thickened, especially the penultimate, which is longer than the terminal ; not usually black and white species, head not usually flat-scaled above Ochlerotatus, p. 14.

5. Eighth segment of female abdomen slender, retractile; male resembling a *Stegomyia* ... ... ... ...HOWARDINA, p. 12.
   Eighth segment of female abdomen broad, truncate (except in *Mimomyia*), not retractile* ... ... ... ... ... ... 6.

A B C D

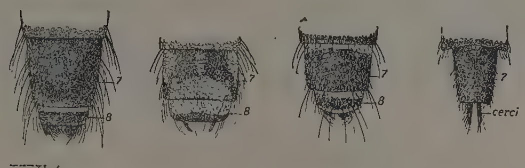


FIG. 1.—Terminal segments of female abdomen (dorsal view) :—A, *Culex tigripes* var. *fuscus*, a specimen with distended abdomen; B, *Culex tigripes*, abdomen not distended; C, *Mimomyia hispida*; D, *Ochlerotatus cumminsi*.

6. Head without any flat scales in the middle above; proboscis never swollen at tip ... ... .. ... ... ... ... 7.
   Head with at least a row of flat scales round the eye-margins, usually almost entirely clothed with flat scales; proboscis often swollen at tip ... ... ... ... ... ... ... 13.
7. Wing-scales very broad and dense ... ... ... ... ... 8.
   Wing-scales not very broad (in African species—but cf. *Culex ager*) ... ... ... ... ... ... ... ... 9.
8. Male palpi as long as proboscis, thin, last joint very short MANSONIOIDES, p. 24.
   Palpi similar in both sexes, very short; middle femora with a tuft of scales at the tip ... ... ... ... ... AËDOMYIA, p. 24.
9. Fork-cells very short; wings nearly bare; male palpi two-jointed MIMOMYIA, p. 35.
   Fork-cells not very short; male palpi three-jointed ... ... 10.
10. Metatarsus of hind legs distinctly shorter than the tibia; male palpi long, the last two joints swollen ... ... ... ... 11.
    Metatarsus of hind legs at least as long as the tibia† (usually longer); male palpi thin (long or rather long) ... ... ... 12.
11. Penultimate joint of male palpi thicker and somewhat longer than terminal one; usually yellow species ... TAENIORHYNCHUS, p. 25.
    Penultimate joint of male palpi thinner but not longer than terminal one; not yellow species; cross-veins almost in a line THEOBALDIA, p. 27.
12. Male palpi longer than proboscis, last two joints curved upwards CULEX, p. 27.
    Male palpi shorter than proboscis, straight...PROTOMELANOCONION, p. 33.

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* *Taeniorhynchus* has this segment rather small and narrow, but not at all retractile; while *Mansonioides* exhibits a very peculiar structure of the female abdomen: the eighth segment is permanently retracted within the seventh, which is very short, being not longer than the eighth segment of *Culex*; there are two very large and broad cerci, which, however, are not prominent like those of *Ochlerotatus*.

† *Culex argenteopunctatus* is an exception to this, as it has the hind tibia slightly longer than the metatarsus.

13. A row of small flat scales round the eyes; basal joint of male palpi with a row of projecting scales; otherwise like *Culex* CULICIOMYIA, p. 33.
    Head mostly or all flat-scaled in middle ... ... ... ... 14.
14. Proboscis not swollen at the tip; fork-cells not very short ... 15.
    Proboscis swollen at tip, or fork-cells very short, first shorter than second ... ... ... ... ... ... ... ... 17.
15. Lateral vein-scales with apices simple; ♂ antennae plumose .. 16.
    Lateral vein-scales with apices dentate; ♂ antennae pilose HODGESIA, p. 35.
16. Medium-sized species, male palpi thin, almost without hairs, and slightly shorter than the proboscis ... EUMELANOMYIA, p. 34.
    Very small species, male palpi short like those of the female MICRAËDES, p. 34.
17. Fork-cells very short, first shorter than second ... ... ... 18.
    Fork-cells not very short, first not shorter than second ... ... 19.
18. Lateral vein-scales absent; male palpi long, two-jointed, apical one swollen; fore and mid claws of male unequal, toothed MIMOMYIA, p. 35.
    Lateral vein-scales present, broad; male palpi very short; male claws not toothed, the front pair small and equal URANOTAENIA, p. 37.
19. Proboscis not hairy; male palpi thin, about two thirds as long as proboscis; silvery markings absent ... INGRAMIA, gen. n., p. 43.
    Proboscis bearing long hairs; male palpi short; clypeus rather long and narrow; silvery markings on pleurae and abdomen HARPAGOMYIA, p. 45.

## Genus MUCIDUS, Theo.

Mon. Cul. I, p. 268 (1901).

**M. scatophagoides**, Theo., Mon. Cul. I, p. 277 (1901).
Additional locality: Uganda (*Dr. Hodges*).

## Genus BANKSINELLA, Theo.

Mon. Cul. IV, p. 468 (1907).

**B. luteolateralis**, Theo., Mon. Cul. II, p. 71 (1901).

Newstead's *Neomelanoconion palpale* (Ann. Trop. Med. I, p. 31, 1907) is referable to this species, as has been proved by an examination of the type (♂).

A single male bred by Dr. A. Ingram may represent a new species allied to *B. luteolateralis*, but it cannot be described without more material. In this specimen the neuration is almost exactly as in *Mimomyia*, and there are very few lateral scales on the veins; the thin palpi and shorter and less plumose antennae and general appearance, however, show it to be a *Banksinella*. The thorax is uniformly clothed with golden scales.

On re-reading the description of *Taeniorhynchus africanus*, Neveu-Lemaire (Arch. Parasit. X, p. 271, 1906), I am inclined to think it is a *Banksinella*. The female only has been described, so it is not possible to say definitely, but the

golden-yellow scales in the middle of the head, produced in front as a tuft of "hairs," and the golden-yellow scales on the sides of the thorax, indicate a possible relation to *Banksinella*. The marbled legs with traces of pale basal banding on the hind tarsi, will distinguish it from the other three species. The species was recorded from the Suez Canal; the only Aëdine I have seen from there which at all corresponds to the description of *T. africanus* is *Ochlerotatus dorsalis*, Mg., which has the hind claws toothed and has speckled wings, the latter character not being mentioned by Neveu-Lemaire. *O. dorsalis* has several times been taken on board ship in the Suez Canal.

## Genus Stegomyia, Theo.

Mon. Cul. I, p. 283 (1901).

*Armigeres*, Theo., Mon. Cul. I, p. 322 (1901).
*Desvoidya*, Blanchard, Les Moustiques, p. 265 (1905).
*Gymnometopa*, Coquillet, Proc. Ent. Soc. Wash. VII, p. 183 (1906).
*Kingia*, Theo., Mon. Cul. V, p. 135 (1910).

This genus was founded upon the world-wide *S. fasciata*, F., with which has been included a number of other species; most of these have since been transferred to other genera. *Stegomyia* is now recognised as a genus of the *Aëdes* group allied to *Ochlerotatus*, but differing from that genus in the thin male palpi. The eighth abdominal tergite in the female is larger than in normal *Ochlerotatus*, and not completely retractile; while the female genital appendages (cerci) are usually rudimentary, though quite well developed in *S. simpsoni*; in *Ochlerotatus* they are nearly always well developed. The genus *Stegomyia* shows considerable variation also in the structure of the male claws and genitalia. In the group *Kingia* (including *apicoargentea*, *fraseri*, *africana*, *luteocephala*, *poweri*, *simpsoni*, *metallica* and *pseudonigeria*), characterised by Theobald as having flat scales in the middle line of the thorax in front (which is the case in all the above eight species), the larger claws of the male are all simple, a very unusual feature. The various forms of the male claws are shown in the following table of the ungual formulae of the African species: *

| | | | |
|---|---|---|---|
| *S. simpsoni* ... | O.0. | O.0. | 0.0. |
| *S. metallica* / *S. africana* / *S. apicoargentea* | O.1. | O.1. | 0.0. |
| *S. luteocephala* ... | O.1. | O.1. | 1.1. |
| *S. fasciata* ... ... | I.0. | O.0. | 0.0. |
| *S. sugens* ... ... | I.1. | I.1. | 0.0. |

The males of the other species are unknown. *S. (Desvoidya) obturbans* has claws of similar structure to those of *S. sugens*, and has very peculiar genitalia.

The type species of *Gymnometopa* (*G. mediovittata*, Coq., not, as Theobald states, *G. sexlineata*, Theo.) has toothed claws in the female, so that this genus becomes a synonym of *Stegomyia* rather than of *Howardina*.

* Some of these formulae differ from those given by Theobald, but I can vouch for their correctness, and have not come across any variations.

If the genus as now defined is dismembered, it may be found necessary to restrict it to the type species, *S. fasciata*, which has a very peculiar character in the scaly clypeus. However, the line taken by Dyar and Knab of sinking both *Stegomyia* and *Ochlerotatus* under *Aëdes* would be wiser, probably, than further subdivision. A middle course has been adopted here.

The specific characters which are most readily appreciated are found in the markings of the hind tarsi, and these have been used for purposes of tabulation. Other characters of diagnostic value are given under each species. All the species are black with white or silvery markings.

*Table of the Species.*

1. Hind tarsi entirely dark (*Desvoidya*) ... .. ... ... 11.
   Hind tarsi with white rings ... ... ... ... ... ... 2.
2. Rings on first four joints of hind tarsi almost equal in length, last joint usually all white (compare *Ochlerotatus fascipalpis*, which may belong here) ... ... ... ... ... ... ... 3.
   Rings on hind tarsi not so arranged (*Kingia*) ... ... ... 4.
3. Clypeus scaly; thorax with lyre-shaped white marks (*Stegomyia*) ... ... ... ... ... ... ... 1. *fasciata.*
   Clypeus not scaly; thorax with six small white spots ... 2. *sugens.*
4. Last two joints of hind tarsi all white; middle femora practically all black in front ... ... ... ... ... 3. *pseudonigeria.*
   Last two joints of hind tarsi not all white; middle femora with a conspicuous white or silvery spot near the middle in front ... 5.
5. White ring on third joint of hind tarsi much broader and more conspicuous than the others; head partly yellow ... ... ... 6.
   White ring on third joint not very broad, though that on the fourth may be; head not at all yellow ... ... ... ... ... 7.
6. Hind tibiae with a large white patch at the base beneath; head-scales mostly black, leaving a small yellow patch in the middle ... ... ... ... ... ... ... 4. *africana.*
   Hind tibiae with a very small yellow patch at the base beneath; head-scales mostly deep yellow ... ... ... 5. *luteocephala.*
7. Fourth joint of hind tarsi mostly or all white ... ... ... 8.
   Fourth joint of hind tarsi mostly or all black; fifth, mostly or all white; all segments of abdomen with broad white bands ... 10.
8. Thorax with a thin median yellow line; abdomen with all segments banded ... ... ... ... ... ... 6. *poweri.*
   Thorax without such line, abdomen with segments 1–3 or 1–4 unbanded ... ... ... ... ... ... ... ... 9.
9. Lateral lobes of scutellum with black scales, last joint of hind tarsi almost all black ... ... ... ... ... 7. *apicoargentea.*
   Lateral lobes of scutellum with white scales, last joint of hind tarsi almost all white ... ... ... ... ... ... 8. *fraseri.*

10. A line of more or less narrow, curved, white scales on either side of the bare space in front of the scutellum ... ... 9. *simpsoni.*
A patch of broad flat silvery scales in this position ... 10. *metallica.*
11. Head with a median patch of flat white scales behind; disc of thorax with light bronzy-brown scales ... ... 11. *albomarginata.*
Head with a white border only; disc of thorax with bronzy-black scales ... ... ... ... ... ... 12. *argenteoventralis.*

1. **S. fasciata,** F. (*Culex*), Syst. Antliatorum, p. 13 (1805).
*Culex calopus*, Meigen, Syst. Bes. I, p. 3 (1818).
*Stegomyia nigeria*, Theo., Mon. Cul. I, p. 303 (1901).

The type of *S. nigeria* is in very bad condition, but there is quite enough of it left to show that it is the unmistakable *S. fasciata.* It was described from a single specimen. In the fifth volume of his Monograph, Theobald records a specimen of *S. nigeria* from Bailundu, Angola: this on examination proves to be a typical, if somewhat rubbed, specimen of *S. pseudonigeria.*

The legs of *S. fasciata* distinguish it from all the other species, as the femora all have a narrow white line running almost their entire length. The abdomen is usually black, with basal and often also apical whitish bands on all the segments; in one desert variety, however, the general hue is light brown instead of black.

*S. fasciata* is common throughout the warmer parts of the world. From the fact that a number of African species are rather nearly related to it, a guess may be hazarded that its original home was in this region.

2. **S. sugens,** Wied., Aus. Zweifl. Ins. I, p. 545 (1828).
*Scutomyia sugens*, Theo., Gen. Ins., Culicidae, p. 19 (1905).
*Stegomyia brumpti*, Neveu-Lemaire, Bull. Soc. Zool. France, XXX, p. 8 (1905).
*Reedomyia albopunctata*, Theo., Mon. Cul. IV, p. 262 (1907).

Dr. Neveu-Lemaire gives such good figures and description of his species (Arch. Parasit. X, 1906, pp. 261–265) as to leave no doubt that it is the same as *S. sugens*, Wied., as interpreted by Theobald. He finds that the hind claws of the male may be toothed or not, or one toothed and the other not. The types of *R. albopunctata* are in poor condition, but quite recognisable.

The species can be easily recognised by the six white spots on the thorax, and also by the white bands near the apices of the femora and near the bases of the tibiae.

Sudan; Abyssinia; Uganda; Gambia; N. & S. Nigeria; Sierra Leone; Gold Coast; Angola; S. Rhodesia; Transvaal; Aden; India; Corsica.

3. **S. pseudonigeria,** Theo., Mon. Cul. V, p. 166 (1910).
*S. wellmani*, Theo., Mon. Cul. V, 163 (1910).

The name *pseudonigeria* is used for this species, because *Danielsia wellmani*, Theo. (1905), known only from the female, may be a *Stegomyia* and not an *Ochlerotatus.* In any case it would be well not to duplicate specific names in the *Aëdes* group.

This species is easily recognisable by the characters given in the table, but it is closely related to *S. poweri*, the markings of the thorax and abdomen being almost identical.

Angola.

4. **S. africana**, Theo., Mon. Cul. I, p. 304 (1901).

*Stegomyia dubia*, Theo., Mon. Cul. V, p. 170 (1910).

*S. dubia* was, to use Theobald's own expression, "described from a worn and damaged female," but there is no visible character by which to separate it from *S. africana*.

Hind femora in front with a large silvery spot about the middle, a small one close to the apex. Thorax with large oblong silvery lateral patches, and a fine yellowish median line, not always visible. Abdomen without distinct bands, but with lateral white spots, extended towards the mid-dorsal line in the middle of each segment; those on the seventh segment visible dorsally. Scales on pleurae silvery.

Sierra Leone; N. & S. Nigeria; Congo; Uganda; Angola; N. E. Rhodesia.

5. **S. luteocephala**, Newstead, Ann. Trop. Med. I, p. 15 (1907).

*Kingia luteocephala*, Theo., Mon. Cul. V, p. 136 (1910).

This species must be taken as the type of the Theobaldian genus *Kingia*, which, if retained, would include all the African *Stegomyia* except *S. fasciata*, *S. sugens*, *S. albomarginata*, and *S. argenteoventralis*.

Very much like *S. africana*. A yellow patch on each side of the thorax above and in front of the roots of the wings. Scales on pleurae pale golden. Abdomen with narrow dull yellowish basal bands. Hind claws toothed.

Sudan; Uganda; S. Nigeria; Congo.

6. **S. poweri**, Theo., J. Econ. Biol. I, p. 18 (1905).

Thorax with a fine median yellowish line, becoming broad and silvery in front; with the usual two lateral silvery-white spots. Abdominal segments 2–6 with dull white basal bands. Hind femora with the basal half white. Hind tibiae broadly white at the base beneath.

Very close to *S. pseudonigeria*, but easily distinguished by the white spot on the mid femora, and the black fifth joint of the hind tarsi.

Congo; British East Africa; N. E. Rhodesia; Bechuanaland; Natal.

7. **S. apicoargentea**, Theo., Mon. Cul. V, p. 172 (1910).

Thorax with two large roundish silvery-white spots, and two smaller ones just in front of the bases of the wings. Median lobe of scutellum with silvery white scales, lateral lobes with black ones. Scales bordering the bare space in front of the scutellum black. Segments 1–4 of abdomen with the lateral patches large, white; on 5–7 they are smaller, silvery; segments 5–8 (sometimes 4–8) with median basal silvery patches. Fore and mid femora with a silvery white line beneath, especially marked near the apex of the fore femora; mid femora silvery at the apex in front; hind femora in front with the basal half and also the apex silvery; behind they are all black, except at the base where they are yellowish. Hind tibiae with a white mark on the *outside* about one-third of the

way from the base, scarcely any white at the base beneath. Fifth joint of hind tarsi practically all black.

Ashanti ; Sierra Leone ; S. Nigeria ; Uganda.

8. **S. fraseri**, sp. n. ♀.

One female from Mpumu Forest, Uganda, July, 1910 (*Capt. A. D. Fraser, R.A.M.C.*), differs in so many small particulars from *S. apicoargentea*, that it is thought advisable to separate it as a distinct species. A complete description does not seem necessary, but so far as observable all the points of difference between it and the preceding are given :

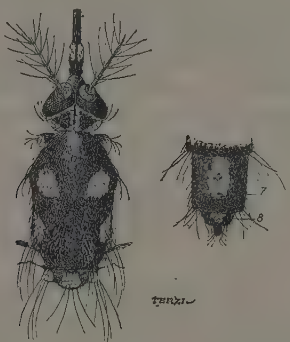


Fig. 2.—*Stegomyia fraseri*, sp. n. Head and thorax, and apex of abdomen (♀).

Scutellum with the lateral lobes entirely clothed with silvery white scales and a similar large central patch on the median lobe. Scales bordering the bare space in front of the scutellum yellowish. Mid and hind femora in front with the apex white, without any silvery metallic lustre. Basal half of hind femora silvery white in front, basal *two-fifths* yellowish white behind. Hind tibiae with a white mark as in *S. apicoargentea*, but in this species it is connected with a large yellowish patch at the base beneath. Last joint of hind tarsi almost all white.

Several of the above characters show that this species is more or less intermediate between *S. apicoargentea*, *S. poweri* and *S. pseudonigeria*, being at once distinguished from the last two by the abdominal markings, and the shape of the spots on the thorax.

*Type* in the British Museum.

9. **S. simpsoni**, Theo., Entomologist, XXXIX, p. 224 (1905).*

*Stegomyia lilii*, Theo., Mon. Cul. V, p. 160 (1910).

*Stegomyia bromeliae*, Theo., Novae Culicidae, 1, p. 10 (1911).

A line of white scales on each side of the bare space in front of the scutellum, usually continued as *two* very fine lines of yellow scales across to the front of the

* Since writing the above notes, I have found that the female claws of this species are variable. I had inadvertently overlooked Theobald's statement that the claws of *S. simpsoni* are all simple, but an examination proved this to be quite correct as regards two Transvaal specimens. Some others, however, from Abyssinia, though *otherwise indistinguishable* from the type of *S. simpsoni*, have toothed claws. This of course invalidates the genus *Howardina*, which must in consequence sink under *Stegomyia*.

mesonotum, but these lines are sometimes indistinct anteriorly or even absent altogether (especially in the male). The female cerci are longer in this than in any other species of the genus, equalling the eighth abdominal tergite in length. I can see nothing to separate *S. lilii* or *S. bromeliae* from *S. simpsoni*, beyond the absence of the yellow lines on the thorax.

Sudan; Abyssinia; Uganda; Nyasaland; Transvaal; Angola.

10. **S. metallica**, nom. n.

*Quasistegomyia dubia*, Theo., Mon. Cul. V, p. 133 (1910).

The new name is proposed to avoid confusion with *Stegomyia dubia*, Theo., which, however, also disappears as a synonym of *S. africana*. The species is probably valid, notwithstanding its close similarity to the preceding, owing to the presence, already referred to, of a tooth on the smaller claw of the fore and mid feet of the male. The thin thoracic lines noticed in *S. simpsoni* are not observable in the single male in the British Museum collection. The patches of flat silvery scales in front of the scutellum unite in front of the bare space into a small patch of white narrow-curved scales. It should be mentioned that the white scales in front of the scutellum in *S. simpsoni* are variable in width. Apart from these points *S. metallica* appears identical with *S. simpsoni*.

Sudan.

11. **S. albomarginata**, Newstead, Ann. Trop. Med. I, p. 16 (1907).

This and the following species are closely allied (possibly local races of one species), but strikingly different from all other African species in markings. They approach closely to the Oriental *Desvoidya obturbans*, and though the males of the African species are unknown there is no doubt that they belong to the *Desvoidya* group of *Stegomyia*.

This species was described by Newstead from one female, with the fifth and following segments of the abdomen missing. It differs from the next species, apart from the characters mentioned in the table, in having very few white scales on the front of the mesonotum.

Congo.

12. **S. argenteoventralis**, Theo. (*Dendromyia*), Mon. Cul. V, p. 588 (1910).

*Dendromyia affinis*, Theo., Mon. Cul. V, p. 589 (1910).

As stated elsewhere this species has no bristles on the metanotum and bears no relation to the SABETHINI. There is a rather large white area on the front of the mesonotum. This species, with *S. albomarginata*, differs from all other African CULICIDAE in having the *front and under surface of the hind femora entirely white*. The venter is also strikingly white, except the last two segments, which are black. In *D. obturbans* the femora are marked in the same way, but the venter sometimes (not always) shows apical dark bands.

Ashanti.

Genus HOWARDINA, Theo.

Mon. Cul. III, p. 287 (1903).

? *Macleaya*, Theo., Entomologist, XXXVI, p. 154 (1903).

*Scutomyia*, Theo., Entomologist, XXXVII, p. 77 (1904).

*Quasistegomyia*, Theo., Second Rept. Wellc. Lab., p. 69 (1906).

This genus differs from *Stegomyia* in that the claws of the female are all simple. Messrs. Dyar and Knab include *Haemagogus*, and say of the genus, "We take

this to be a group specialised off from *Aëdes*, the tarsal claws of the female having lost the tooth. The small end joint of the [female] palpus is retained, which differentiates the genus from *Culex*." *Haemagogus* differs in having the prothoracic lobes large and approximated.

1. **H. unilineata**, Theo. (*Quasistegomyia*), Second Rept. Wellc. Lab, p. 70 (1906).

*Stegomyia gebeleinensis*, Theo., Mon. Cul. V, p. 157 (1910).

„ *gelebeinensis*, Theo. (error), Mon. Cul. V, p. 151 (1910).

Both the types are very much broken, but the thorax of each remains in fairly good preservation. Both show two small areas of black flat scales on the mesonotum immediately preceding the scutellum, which is clothed with flat white scales. On this character Theobald founded his genus *Quasistegomyia*.

*H. unilineata* is easily differentiated from other African CULICIDAE by the white line down the middle of the mesonotum. It resembles *Stegomyia* in general appearance, and the tarsal banding is similar to that of *S. fasciata* and *S. sugens*. The species is represented in the Oriental Region by the common *H.* ("*Stegomyia*") *scutellaris*. This resembles *H. unilineata* in most respects, but lacks the pair of small round white spots on the posterior half of the mesonotum and the spots on the distal half of the front of the mid femora. These two characters will also distinguish *H. unilineata* from *H. pseudoscutellaris*, Theo., recently described from Fiji. *H. grantii*, Theo., from Sokotra, is not so closely allied. It has distinct white lines on the femora and tibiae, and different thoracic markings.

Sudan; N. Nigeria (Baro, 2 ♀, *Dr. Ingram*); British E. Africa (Dolo, 1 ♀, *Dr. R. E. Drake-Brockman*).

2. **H. (?) pembaensis**, Theo. (*Aëdes*), Mon. Cul. II, p. 235 (1901).

*Verrallina pembaensis*, Theo., Mon. Cul. V, p. 495 (1910).

This was described from a single female in bad condition, and must remain of doubtful position until more material can be obtained. The eighth segment of the abdomen seems to be broken off, so that I am not quite sure that it belongs to the *Aëdes* group. What scales are left on the head are flat, and, except for a row round the eye-margins, black. The thoracic scales seem to have been blackish, from the few that are left, and there are a few flat white scales on the scutellum. Abdomen blackish, with small basal lateral white spots. Legs brownish, unbanded.

Pemba Island.

3. **H. (?) lineata**, Theo. (*Pseudohowardina*), Entomologist, XLV, p. 92 (1912).

"♂ and ♀. Head deep brown, with a median white line and a thin white line around the eyes; proboscis deep brown, with a line of white scales on the basal half. Thorax deep brown, with three thin pale yellow lines, the median one forked around the bare space in front of the scutellum, a thin white line on each side; two broken white lines on the pleurae and spots. Abdomen deep brown, with traces of apical white bands and apical spots. Legs deep brown, unbanded, femora with a white line beneath, and in certain lights the tibiae pale yellow. Male palpi acuminate, no hair tufts, brown. Length, ♀ 3·5–4·5, ♂ 4 mm."

Described by Mr. Theobald from a male and three females from the Transvaal (Onderstepoort). As he does not mention the structure of the female claws and abdomen I am not certain that it is correctly placed here. There is a single male in the British Museum collection from Natal (Ulundi, 5,000–6,000 ft., September, 1896, *G. A. K. Marshall*). There is no other African species at all resembling this.

Genus OCHLEROTATUS, Arrib.

Rev. Mus. La Plata II, p. 143 (1891).

? *Gilesia*, Theo., Mon. Cul. III, p. 233 (1903).
*Acartomyia*, Theo., Mon. Cul. III, p. 251 (1903).
*Finlaya*, Theo., Mon. Cul. III, p. 281 (1903).
*Aedimorphus*, Theo., Mon. Cul. III, p. 290 (1903).
*Culicelsa*, Felt, N.Y. State Mus. Bull., p. 391b (1904).
*Culicada*, Felt, *l.c.*
*Ecculex*, Felt, *l.c.*
*Protoculex*, Felt, *l.c.*
? *Gualteria*, Lutz, Mosq. Brazil, p. 47 (1904).
? *Danielsia*, Theo., Entom. XXXVII, p. 78 (1904).
*Pseudoculex*, Dyar, Proc. Ent. Soc. Wash. VII, p. 47 (1905).
*Chrysoconops*, Goeldi, Os Mosq. no Pará, p. 114 (1905).
*Reedomyia*, Ludlow, Can. Ent. XXXVII, p. 94 (1905).
*Pecomyia*, Theo., J. Econ. Biol. I, p. 24 (1905).
*Pseudograbhamia*, Theo, J. Bomb. Nat. Hist. Soc., p. 244 (1905).
*Phagomyia*, Theo., Gen. Ins. Fam. Cul., p. 21 (1905).
*Polyleptiomyia*, Theo., *l.c.*
*Lepidotomyia*, Theo., *l.c.*, p. 22.
*Lepidoplatys*, Coq., Science, XXIII, p. 314 (1906).
? *Cacomyia*, Coquillet, U.S. Dept. Agric. Bull. II, p. 16 (1906).
? *Stegoconops*, Lutz, Imprensa Medica, (1906).
*Pseudoskusea*, Theo., Mon. Cul. IV, p. 192 (1907).
*Pseudohowardina*, Theo., Mon. Cul. IV, p. 223 (1907).
*Protomacleaya*, Theo., Mon. Cul. IV, p. 253 (1907).
*Duttonia*, Newst., Ann. Trop. Med. I, p. 17 (1907).
*Mimeteculex*, Theo., Third Rep. Wellc. Lab., p. 258 (1908).
*Geitonomyia*, Leic., Stud. Ins. Med. Res., Fed. Malay States, III, p. 134 (1908).
*Myxosquamus*, Theo., Mon. Cul. V, p. 225 (1910).
*Neopecomyia*, Theo., Mon. Cul. V, p. 261 (1910).
*Stenoscutus*, Theo., Mon. Cul. V, p. 263 (1910).
*Bathosomyia*, Theo., Mon. Cul. V, p. 267 (1910).
? *Molpemyia*, Theo., Mon. Cul. V, p. 479 (1910).
? *Andersonia*, Strickland, Entom., p. 250 (1911).
*Leslieomyia*, Christ., Paludism, No. 2, p. 68 (1911).

A query prefixed to a name in the above list of synonyms indicates that the genus was described from the female only, and consequently it may possibly

belong to one of the other genera of the *Aëdes* group, though in each case the general appearance would seem to indicate an *Ochlerotatus*. *Finlaya* is perhaps the most distinct of the various groups which have received generic names, owing to the spotted wings and more or less tufted venter, but I have no hesitation in placing it as a synonym of *Ochlerotatus*. In the type species of *Finlaya* (*F. poicilia*, Theo.), the claws of the female were incorrectly described as simple; they are really toothed on the fore and mid legs.

Since writing in this periodical last October, I have seen specimens of what I take to be *Ochlerotatus albifasciatus* (Macq.) Arrib., from Mendoza, Argentina (*G. Boag*). This species is the type of the genus *Ochlerotatus;* the specimens referred to appeared to belong to the same group as the European *O. dorsalis*.

Even in *Ochlerotatus* there is some variation in the form of the male palpi. The thickness of the two apical joints varies, and also their relative length as compared with the basal joint. In one species (*O. irritans*) the palpi are distinctly shorter than the proboscis, while in an Indian species they are only two-thirds as long. In *O. simulans* and *O. apicoannulatus* the last two joints are scarcely at all swollen, of about equal length and less hairy than usual. In spite of these differences, and the great variation in scale characters, it has not been found possible to split up the genus satisfactorily. In the majority of species the male palpi conform rather closely to the type found in *O. hirsutus* (Bull. Ent. Res. II, p. 249, fig. 1).

*Ochlerotatus* differs from *Aëdes* in having the male palpi elongate, about equal in length to the proboscis; and from *Stegomyia* in having the last two joints of the ♂ palpi more or less swollen, and with distinct hair tufts; the penultimate joint is a little longer and distinctly thicker than the terminal. There is apparently no structural character by which the females of *Aëdes*, *Ochlerotatus*, and *Stegomyia* can be distinguished, and this lends support to the view held by Dyar and Knab, that the three genera should all be merged into *Aëdes*. The difference in the males, however, is so striking, that it is difficult to see how they can all be regarded as belonging to one genus. The three genera are here treated as distinct, though it is recognised that they are much more closely related among themselves than any of them are to the *Culex* and *Taeniorhynchus* group.

A complete table of the African species is given. The arrangement of those species without flat scales on the scutellum has been altered, in order that they may be tabulated, so far as possible, by characters easily observable with a hand-lens. The structure of the *hind* claws is evidently of no great importance, and not even trustworthy for specific distinctions; Neveu-Lemaire in a large series of *S. sugens* found some specimens with both hind claws simple, some with both toothed, and some with one toothed and one simple.

The statement previously made that *Ochlerotatus* is mainly a Palaearctic genus is of course a complete error.

*Table of African* Ochlerotatus.

1. Hind tarsi with at least one white band ... ... ... ... 2.
   Hind tarsi entirely dark ... ... ... ... ... ... 13.

2. First (i.e., metatarsus) and second tarsal joints only with white bands, that on the second joint much the broader ... ... ... 3.
   All joints of hind tarsi with white bands ... ... ... ... 4.
3. Thorax with a double median row and lateral patches of flat metallic silvery scales; head silver-scaled ... ... ... 1. *longipalpis.*
   Thorax laterally and head with whitish narrow-curved scales. 2. *wellmani.*
4. Tarsal bands on both ends of joints ... ... ... ... ... 5.
   Tarsal bands on bases of joints only ... ... ... ... ... 10.
5. Small species (about 4 mm.); tarsal bands clear white and almost entirely at the apices of the joints ... ... ... ... 6.
   Larger species (about 6 mm.); tarsal bands yellowish white and equally distributed on each side of the articulations ... ... 8.
6. Thorax, and hind femora before the apex, with small silvery spots... 7.
   Thorax and hind femora without silvery spots, except at apex of the latter... ... ... ... ... ... ... 3. *apicoannulatus.*
7. Spots of thorax composed of broad flat scales; fore and mid femora with a silvery spot before apex ... ... ... 4. *marshalli.*
   Spots of thorax composed of narrow curved scales, wings with a silvery spot at base of costa; fore and mid femora unspotted. 5. *simulans.*
8. Thorax brown with two whitish longitudinal stripes... ... 6. *dorsalis.*
   Thorax almost uniformly brown or brassy brown ... ... ... 9.
9. Abdomen almost all pale brown ... ... ... 7. *longisquamosus.*
   Abdomen dark brown banded with white ... ... 8. *pulcritarsis.*
10. Legs marbled, female palpi brownish, white-tipped ... ... ... 11.
    Legs not marbled, female palpi black, with a distinct white ring in middle ... ... ... ... ... ... 9. *fascipalpis.*
11. Wings mottled with black and white scales; dark species .. ... 12.
    Wings not mottled; more brownish species; costal fringe whitish beyond middle ... ... ... ... ... 10. *hirsutus.*
12. Abdominal segments with apical lateral yellowish spots. 11. *durbanensis.*
    Abdominal segments without such spots ... ... { 12. *nigeriensis.* ? 12a. *sudanensis.* 12b. *caballus.* }
13. Scutellum clothed with white or silvery scales, normally all flat, or head covered mostly with flat scales ... ... ... .. 14.
    Scutellar scales neither flat nor white, head with only narrow scales in middle ... ... ... ... ... ... ... ... 24.
14. Scutellar scales all white or silvery white and all flat (except in varieties of *O. minutus*) ... ... ... ... ... ... 15.
    Scutellar scales partly black, some narrow; head mostly flat-scaled 23.
15. Hind femora with a round white spot before the apex ... ... 16.
    Hind femora without such spot ... ... ... ... ... 17.
16. Mid femora also with white spot before apex... 13. *argenteopunctatus.*
    Mid femora without such spot ... ... ... ... 14. *domesticus.*
17. Thorax with four silvery spots ... ... ... 15. *punctothoracis.*
    Thorax without silvery spots ... ... ... ... ... ... 18.

18. Thorax whitish at the sides, blackish in the middle; large species 16. *ornatus.*
Thorax not whitish at the sides; smaller species ... ... ... 19.
19. Abdomen of female with distinct basal pale bands on all the segments; hind tibiæ not conspicuously white at apex. 17. *alboventralis.*
Abdomen of female all dark above (normally), though that of the male has distinct silvery basal bands on all the segments; hind tibiæ with a more or less conspicuous silvery white mark at the apex ... ... ... ... ... ... ... ... ... 20.
20. Head-scales (in female) nearly all dark ... ... 18. *africanus.*
Head-scales largely pale ... ... ... ... ... ... 21.
21. Claspers of male genitalia formed like a two-pronged fork, head scales whitish ... ... ... ... ... 19. *albocephalus.*
Claspers of male genitalia not fork-like, swollen at the tip ... ... 22.
22. Thoracic scales narrower, smaller, bronzy ochreous or yellowish more or less mixed with blackish brown ... ... 20. *minutus.*
Thoracic scales broader, larger, dull ochreous ... 21. *abnormalis.*
23. Black species ... ... ... ... ... ... 22. *nigricephalus.*
Brown species ... ... ... ... ... ... ... 23. *irritans.*
24. Very yellow species, recalling *Taeniorhynchus aurites*, etc. 24. *ochraceus.*
Not yellow species (but a variety (?) of *O. nemorosus* is all ochreous) 25.
25. Abdominal segments with complete basal pale bands ... ... 26.
Abdominal segments without complete basal pale bands ... ... 29.
26. Wings, femora and tibiæ more or less marbled; Palaearctic species 25. *nemorosus.*
Wings, femora and tibiæ not at all marbled; Ethiopian species ... 27.
27. Hind claws of female simple; thorax without distinct lines. 26. *quasiunivittatus.*
Hind claws of female toothed ... ... ... ... ... ... 28.
28. Smaller species, very dark; thorax not lined ... 27. *caliginosus.*
Larger, lighter-coloured species; thorax more or less ornamented with yellowish lines ... ... ... ... 28. *dentatus.*
29. Large species; thorax without distinct ornamentation; hind tibiæ with a small white spot at apex ... ... ... 29. *cumminsi.*
Medium-sized species; thorax with distinct short golden lines in front of scutellum; hind tibiæ with a rather broad white band at apex ... ... ... ... ... ... 30. *leucarthrius.*

1. **O. longipalpis,** Grünberg (*Stegomyia*), Zool. Anz. 1905, p. 383.
*Stegomyia pollinctor*, Graham, An. Mag. Nat. Hist. (8) V, p. 271 (1910).
*Kingia pollinctor*, Theo., Mon. Cul. V, p. 628 (1910).

This is a very distinct species which cannot possibly be confounded with any other, the general black colour and metallic silvery markings, with the peculiar markings of the hind tarsi, making it very distinctive. The female palpi are fully one-third as long as the proboscis, and somewhat swollen, and there are

some other points of structure, noted elsewhere, in which this species diverges from typical *Ochlerotatus*.

S. Nigeria; Camerun; Togo.

2. **O. wellmani,** Theo. (*Danielsia*), Entomologist, XXXVIII, p. 103 (1905).

Angola; Sierra Leone (Daru, *Dr. J. C. Murphy*, 1 ♀ taken June 1911); British East Africa (Mumias, *T. J. Anderson*, 1 ♀ taken 29. iv. 1911).

3. **O. apicoannulatus,** nom. n.

*Aedimorphus alboannulatus*, Theo., Entomologist, XXXVIII, p. 154 (1905), *nec Culex* (*Ochlerotatus*) *alboannulatus*, Macq., Dipt. Ex. Sup. IV, p. 10 (1850).

This forms, with the two following, a group of very closely allied species, distinguished collectively from all the rest of the genus, and in fact from all other Culicini, by the peculiar leg-markings (*vide* key). It is hardly worth while to point out that the fact that these three species have till now been placed in three different genera, affords one more proof of the absolute impracticability of a classification based mainly on scale characters.

Sierra Leone.

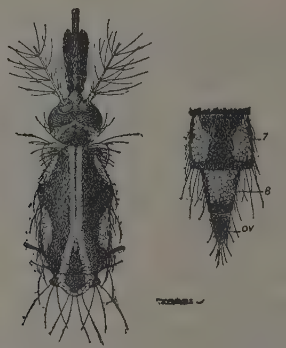


Fig. 3.—*Ochlerotatus longipalpis*, Grünb. Head and thorax, and apex of abdomen (♀), *ov.* protruded ovipositor.

4. **O. marshalli,** Theo. (*Stegomyia*), Mon. Cul. I, p. 310 (1901).

*Scutomyia marshalli*, Theo., Gen. Ins. Culicidae, p. 19 (1905).

S. Rhodesia.

5. **O. simulans,** Newstead & Carter (*Reedomyia*), Ann. Trop. Med. V, p. 240 (1911).

Seems only to differ from *O. marshalli* by the characters given in the key. One specimen (paratype) has the white spot on the *hind* femora only, not on the others, and Mr. Carter informs me that "the spots on the fore and mid femora of the type are simply due to small patches of scales being rubbed off."

Ashanti.

9. **O. fascipalpis**, sp. n.

♀. *Head* clothed mainly with loosely applied flat scales, a few narrow curved and some upright forked on the nape, pale yellow; the flat scales are mostly pale yellow, but there are a few black ones in front, and a pair of sublateral triangular patches of the same colour. Antennae and clypeus black, first antennal joint with small whitish scales on the inside, clypeus bare. Palpi black-scaled, with a median white band; fully one-fourth as long as the proboscis, rather thin. Proboscis black-scaled, a few white scales in the middle of its upper surface. *Thorax* black, clothed above with black and pale yellow narrow curved scales; the distribution of colour will best be understood by a glance at the figure. Pleurae with patches of flat white scales. Scutellum with flat white scales on the median lobe. *Wings* with the veins clothed with black scales, a few white ones at the extreme base of the costa; first fork-cell a little longer than second, its stem rather more than half its length. Auxiliary vein terminating at the costa just before base of first fork-cell. *Legs* black, femora whitish on the basal two-thirds, and at the extreme tip; all the tarsal joints with white basal bands, that on the metatarsus the narrowest. Claws of hind legs simple. *Abdomen* black-scaled, the segments with narrow basal white bands, which expand very slightly laterally and in the middle, on all eight segments. Venter black, with basal white bands on the first five segments. Ovipositor not visible. *Length* 4 mm., without proboscis.

*Type* in the British Museum; presented by the Entomological Research Committee.

Described from a single female, in perfect condition, bearing the label "Little Ruaha River, South Usangu District, 3,500 ft., German E. Africa. 28. xi. 1910. S. A. Neave."

Fig. 4.—*Ochlerotatus fascipalpis*, sp. n.

This species most resembles *O. hirsutus*, but is much darker and has banded palpi and a flat-scaled scutellum. The thoracic adornment is very suggestive of *O. wellmani*, *O. ornatus* and *O. lateralis*, and perhaps the real relationships of the insect are with those species. The three last-mentioned, with *O. longipalpis*, form a distinct group, in which the eighth abdominal tergite in the female is larger and broader than usual, and the cerci are minute or absent; the male palpi of *O. lateralis* and *O. longipalpis* are scarcely swollen. This group, therefore, seems to connect *Ochlerotatus* with *Stegomyia*.

10. **O. hirsutus,** Theo., Mon. Cul. I, p. 392 (1901).

Additional localities: British East Africa (Kitui, 7. vi. 1911, *T. J. Anderson*); Uganda (Busoga, *Dr. Hodges*); Gold Coast (one small female).

12. **O. nigeriensis,** Theo., Mon. Cul. V, p. 281 (1910).

*Culicelsa fryeri*, Theo., Trans. Linn. Soc. Lond., XV, 1, p. 84 (1912).

Additional locality: Bole, Gold Coast (*Dr. A. Ingram*); good series of both sexes bred from larvae.

12*a*. **O. sudanensis,** Theo. (*Culex*), Fourth Rept. Wellc. Lab. Vol. B, p. 154 (1911).

This is evidently closely allied to *O. nigeriensis*, though the author does not compare it with that species, since he places it in *Culex*. He does not say whether there are any white scales on the wings, and so it may not be correctly placed in the table. Apparently it is distinct from *O. nigeriensis*, since the thorax is described as "tesellated with golden brown and deep brown, showing traces of linear arrangement." In *O. sudanensis* the proboscis is said to be unbanded, in *O. nigeriensis* it is pale in the middle beneath and at the sides.

Sudan.

12*b*. **O. caballus,** Theo., Entomologist, XLV, p. 93 (1912).

*Grabhamia caballa*, Theo., *l.c.*

"♀. Head and thorax with rich deep golden scales, a dark patch on each side of the head. Thorax showing traces of linear markings, and with golden chaetae. Palpi and proboscis deep brown: antennae brown. Abdomen deep brown, with basal creamy bands which spread out to form large lateral spots, and also send out median processes which in some specimens form a dorsal line. Legs brown, mottled with creamy scales, and with prominent basal pale bands; ungues all equal and uniserrate. Wings with brown and creamy scales. Length 4 to 5 mm.

"*Habitat.*—Onderstepoort, Transvaal.

"*Observations.*—Described from twelve females. It comes near *G. durbanensis*, Theob., but can be told by the hind ungues being uniserrate."

13. **O. argenteopunctatus,** Theo. (*Stegomyia*), Mon. Cul. I, 316 (1901).

This and the two following species, again, form a very closely allied group, and it may be doubted whether or not the three forms are really distinct: there appear to be no other constant differences than those given, though there is considerable variability.

Sudan; N. Nigeria; Uganda; S. Rhodesia.

14. **O. domesticus,** Theo. (*Uranotaenia*), Mon. Cul. II, p. 253 (1901).

*Aedimorphus domesticus*, Theo., Mon. Cul. III, p. 291 (1903).

S. Nigeria; Ashanti; Uganda.

15. **O. punctothoracis,** Theo. (*Aedimorphus*), Ann. Mag. Nat. Hist. (8) V, p. 374 (1910).

*Aedimorphus punctithorax*, Theo., Mon. Cul. V, p. 205 (1910).

It should be mentioned here that the figure given by Theobald (Mon. V, p. 206) to represent the male genitalia of this species, in reality refers to *O. albocephalus*.

The slide no doubt was wrongly labelled. Very abundant at Accra. One of the two females labelled "*Stegomyia argenteopunctata*, type" by Theobald is this species.

Gold Coast; Angola; S. Rhodesia.

16. **O. ornatus**, Mg., Syst. Bes. I, p. 5 (1818).

The specimen recorded by Theobald (Mon. Cul. III, p. 191) as *Culex lateralis*, Mg., is, I find, not that species, but closely related to it and probably referable to *O. ornatus*. When I included *O. lateralis* as African in my table (Bull. Ent. Res. Oct. 1911, pp. 248, 250), I had not examined the specimen. *O. ornatus* has complete pale bands on the abdomen, whereas *O. lateralis* has only lateral pale spots at the base of each segment. In the Algerian specimen referred to and in another from Fez, Morocco (May 1909, *Major C. E. P. Fowler*), the scutellum bears mostly flat white scales (the Algerian specimen is considerably denuded). As these are the only two specimens of *O. ornatus* which I have seen, I cannot say whether the flat-scaled scutellum is normal or not. Ficalbi attributes the name *C. ornatus*, Mg. to another species.

17. **O. alboventralis**, Theo. (*Protomacleaya*), Mon. Cul. V, p. 251.

Angola.

18. **O. africanus**, Newstead (*Duttonia*), Ann. Trop. Med. 1, p. 20 (1907).

The name *africanus* is retained for the present, but if *Ochlerotatus* and *Stegomyia* be merged, it will be preoccupied by *S. africana*, Theo., similarly if *Taeniorhynchus africanus*, Neveu-Lemaire be shown to be an *Ochlerotatus*, a new name will have to be proposed for Newstead's species.

*O. africanus* was described from a single female, and its validity as a species is somewhat doubtful. It seems, however, to be distinct by the character given in the key. The thorax is rubbed, but the scales appear to be all dark.

Congo.

19. **O. albocephalus**, Theo. (*Stegomyia*), Mon. Cul. III, p. 140 (1903).

*Polyleptiomyia albocephala*, Theo., Gen. Ins. Culicidae, p. 21 (1905).

This species is only known to me in the male sex. It is possible that its female may have been included under *O. minutus*, but if so I do not see how to distinguish them. The male genitalia are very peculiar and have been figured by Theobald as those of *O. punctothoracis* (Mon. Cul. V, p. 206, fig. 79). Of the mosquitos whose genitalia I have seen, *O. cumminsi* alone exhibits a somewhat similar structure in these organs.

Gambia; Gold Coast.

20. **O. minutus**, Theo. (*Stegomyia*), Mon. Cul. I, p. 319 (1901).

*Duttonia tarsalis*, Newstead, Ann. Trop. Med. I, p. 18 (1907).
*Reedomyia biannulata*, Theo., Mon. Cul. IV, p. 263 (1907).
*Reedomyia neobiannulata*, Theo., Mon. Cul. V, p. 255 (1910).
*Reedomyia bipunctata*, Theo., Mon. Cul. V, p. 256 (1910).
*Neopecomyia uniannulata*, Theo., Mon. Cul. V, p. 261 (1910).
*Stenoscutus africanus*, Theo., Mon. Cul. V, p. 263 (1910).
*Reedomyia seychellensis*, Theo., Trans. Linn. Soc. Lond. XV, 1, p. 83 (1912).

This is a variable species, and not very easy to recognise. Between extreme forms there is considerable difference in the colour and form of the scales, but I can find no constant differences between the forms enumerated above, and so have included them all as one species under the oldest name. I may be wrong in this, but if there is more than one species more material and more minute study will be required before they can be properly separated. It is with some reluctance that I accord specific rank to *O. africanus*, Newstead (described from one female) and *O. abnormalis*, Theo. (described from two males, one dissected). The most characteristic features of the different forms may be briefly pointed out.

i. Typical form (*minutus*). Head bearing flat scales over the occiput; scales dark in the middle and at the sides, leaving a V-shaped pale area. Pale scales of thorax forming a pair of distinct spots about the middle of the mesonotum.

ii. var. *tarsalis* (= *bipunctatus*). Like the type form, but without flat scales over the top of the head, the scales in this position being narrow and curved. This difference, which is regarded as of generic value by Theobald, is not constant, and intermediates occur between these two varieties. Some specimens from Uganda are larger than those from Ashanti and have the pale spots on the thorax less marked; the integument is dark brown instead of red-brown.

iii. var. *biannulatus* (= *neobiannulatus*). Head scales all pale in the middle; thorax without distinct pale spots, though the light and dark scales are not evenly mixed; abdomen of female sometimes with traces of pale bands at the bases of segments (lateral white spots are always present). *R. neobiannulata* was proposed by Theobald, without any apparent reason, as a substitute for *R. biannulata*, which was founded on some males from Sierra Leone. Although the female of *R. biannulata* was undescribed, we were given characters by which it might be distinguished from *R. neobiannulata*, and also the male genitalia of the two were said to differ, even though both names were given to the same specimens.

iv. var. *uniannulatus*. Like the preceding, but there are some narrow scales on the apical portion of the middle lobe of the scutellum.

v. var. *stenoscutus*, nom. nov. (= *africanus*, Theo., *nec O. africanus*, Newst.). This is the most distinct of the varieties of this species. The abdominal segments of the female have distinct pale basal bands; the scutellum bears a considerable number of narrow scales, mostly on the middle lobe (but this character is variable); the hind femora are whitish beneath on the whole of their length (in the other varieties they are usually darkened towards the apex on the under side); in some specimens the white spot at the apex of the hind tibiae is rather indistinct.

Sierra Leone; Ashanti; Gold Coast; Uganda; Congo; Angola; Seychelles Is.

21. **O. abnormalis**, Theo. (*Bathosomyia*), Mon. Cul. V, p. 238 (1910).

The hind claws (♂) are unequal and simple. The genus *Bathosomyia* seems to have been founded principally on the characters of the male genitalia; but in the single mounted specimen these organs cannot be properly made out. They seem to be similar to those of the preceding species.

Ashanti.

22. **O. nigricephalus**, Theo. (*Stegomyia*), Rept. Liverp. S. Trop. Med. Mem. IV, app. (1901).
*Phagomyia nigricephala*, Theo., Gen. Ins. Culicidae, p. 21 (1905).
*Myxosquamus paludosus*, Graham, Ann. Mag. Nat. Hist. (8) V, p. 270 (1910).

This species should be easily recognised by its almost uniform black colour, the only other black species being *O. caliginosus*, which has basal white bands on the abdominal segments, while in this species there are only white lateral spots. *O. nigricephalus* has a similar scutellar scaling to that of the following species, but the scales are all black. The type of *O. nigricephalus* appears to have been lost (it is missing from the British Museum Collection), but from the description, and from a damaged specimen so named by Theobald, there seems little doubt that it is the same as Graham's species.

S. Nigeria.

23. **O. irritans**, Theo. (*Stegomyia*), Rept. Liverp. S. Trop. Med., Mem. IV, app. p. iii. (1901).
*Catageiomyia senegalensis*, Theo., Rept. Liverp. S. Trop. Med., Mem. XI, app. p. 1 (1903).
*Aedimorphus albotaeniatus*, Theo., Mon. Cul. V, p. 204 (1910).
*Myxosquamus confusus*, Theo., Mon. Cul. V, p. 225 (1910).
*Phagomyia irritans*, Theo., Gen. Ins. Culicidae, p. 21 (1905).

The members of the group to which *O. irritans* belongs are not very easily separated. Perhaps the best character for this species is the scaling of the scutellum. The middle lobe bears a variable number of cream-coloured narrow curved scales, mixed with flat black ones, some or all of the flat ones being occasionally also cream-coloured; the lateral lobes bear only creamy narrow curved scales. The abdominal segments have narrow basal pale bands; the tip of the hind tibiae is white, but not conspicuously so. It thus approaches rather closely to *O. minutus* var. *stenoscutus*. The species seems to be very abundant at Accra.

There is no doubt about the synonymy given above. The remarks made concerning *O. apicoannulatus* (p. ) might be applied with added force here.

Senegal; Gold Coast; S. Nigeria.

24. **O. ochraceus**, Theo., Mon. Cul. II, p. 103 (1901).
Additional locality: British East Africa (*C. W. Woodhouse* and *W. Kennedy*).

26. **O. quasiunivittatus**, Theo., Mon. Cul. II, p. 32 (1901).
Additional localities: British East Africa; Uganda.

28. **O. dentatus**, Theo. (*Culex*), First Rept. Wellc. Lab., p. 75 (1905).
*Culex pallidopunctata*, Theo., U. South Afr. Dept. Agric., First Rept. Vet. Res., p. 267 (1911).

Theobald does not compare *C. pallidopunctata* with *O. dentatus*, but describes the hind claws of the female as being simple; he states that *C. pallidopunctata* was described from a series of 58 females. Evidently this series was really a mixed one, for out of four females presented by him to the British Museum, two (including the holotype) are typical *O. dentatus* with toothed hind claws; one appears to be *O. quasiunivittatus* from the thoracic scaling, but the hind tarsi are missing; the fourth is a *Culex pipiens* var. *pallidocephalus*!

**29. O. cumminsi**, Theo., Mon. Cul. III, p. 214 (1903).

Additional locality: British East Africa (S. slopes of Mt. Elgon, 5100–5800 ft., 8–13.vi.11., *S. A. Neave*); three small females, typical in other respects.

It is highly improbable that the egg-raft figured by Theobald (Mon. Cul. V, p. 395) has anything to do with this species.

Genus MANSONIOIDES, Theo.

Mon. Cul. IV, p. 498 (1907).

? *Etorleptiomyia*, Theo., First Rept. Wellc. Lab., p. 71 (1904).

? *Etiorleptiomyia*, Theo., Mon. Cul. V, p. 454 (1910).

? *Etorilepidomyia*, Alcock (*emend.*), Ann. Mag. Nat. Hist. (8) VIII, p. 249 (1911).

*Diceromyia*, Theo., Fourth Rept. Wellc. Lab., Vol. B, p. 151 (1911).

The genus *Diceromyia* was founded on characters of the male genitalia of a species (from the Sudan) which must be very close indeed to *Mansonioides nigra*, Theo. Apart from the forked claspers, however, there does not seem to be any great peculiarity in this insect, which I have not seen. The description of the male palpi is quite sufficient to show that *Diceromyia* is synonymous with *Mansonioides*, and the close resemblance of the female to *M. nigra* removes any doubt that that species is correctly placed here. *D. africana* ♀ is said to differ from *M. nigra* in the absence of the white bands of the palpi and of the irregular white apical bands to the abdominal segments, and also in the fore and mid claws being toothed. This last statement is in all probability an error, as no member of the *Culex-Taeniorhynchus* group has toothed claws in the female. The name *africana* is preoccupied in this genus.

**M. (?) mediolineata**, Theo. (*Etorleptiomyia*), First Rept. Wellc. Lab., p. 71 (1904).

*Etorleptiomyia mediopunctata*, Theo., Gen. Ins. Culicidae, p. 44 (1905).

*Anisocheleomyia quadrimaculata*, Newstead, Ann. Trop. Med. 1, p. 32 (1907).

In comparing the types of *E. mediolineata* and *A. quadrimaculata* the only differences I could detect were slight ones in the wing-markings, and it seems best to regard these as within the range of individual variation, especially as the two previously recorded specimens differ in this respect. The markings of the wings recall those so often found in *Anopheles*, e.g. *A. costalis*. So far as I can see there is no difference in breadth between the two claws on any of the legs of the type of *A. quadrimaculata*.

Additional locality: Upper Shire River, Nyasaland, 3. viii. 11 (*Dr. J. B. Davey*).

Leicester describes as *Etorleptiomyia completiva* a very distinct species (from one male), which from the structure of the proboscis and palpi is evidently an *Ingramia* (*see* p. 43). He says the wing-scales are exactly as in *E. mediolineata*.

Genus AËDOMYIA, Theo. (*emend.*)

*Aedeomyia*, Theo., Mon. Cul. II, p. 218 (1901).

The relationships of this genus seem to be with *Taeniorhynchus*, as is indicated (1) by the structure of the male claws; (2) by the broad dense wing-scales.

1. **A. catasticta,** Knab, Ent. News, XX, p. 387 (1909).

*A. squammipenna*, Theo., Mon. Cul. II, p. 219 (1901), part (*nec Aëdes squamipennis*, Arrib.).

Knab described *A. catasticta* from the Philippine Islands, and says of it, "This species much resembles *Aedeomyia squamipennis* Arrib., but differs in many details, and these differences appear to be constant. In *A. squamipennis* the proboscis has a broader white ring and the spot behind it is larger and yellow while the apical white ring is very narrow. In *A. squamipennis* the palpi, besides the white apex, have a large yellow patch in the middle. On the mesonotum the ocher-yellow scales are distributed nearly over the entire surface and the white spots on the wings are much smaller than in the Philippine specimens. The male genitalia of the two species show specific differences." Before reading Knab's description I had separated the British Museum series of *Aëdomyia squamipennis* into two species, one occurring in S. America only and the other from the Ethiopian and Oriental regions; on comparing the latter with the description of *A. catasticta*, it was found to apply in almost every detail both to the African specimens and those from the Oriental region. To the distinctions given by Knab between *A. catasticta* and *A. squamipennis* I can add another which seems to be constant and is easily seen; the white ring embracing the tip of the metatarsus and the base of the second tarsal joint of the hind legs is narrow in *A. squamipennis*, but broad and rather conspicuous in *A. catasticta.*

Sudan; S. Nigeria; N. Nigeria; Gold Coast.

2. **A. africana,** Neveu-Lemaire, Arch. Parasit. X, p. 273 (1906).

Differs from *A. catasticta* in having the palpi entirely dark brown, the proboscis has only a median pale ring.

Dufile.

### Genus Taeniorhynchus, Arrib.

Rev. Mus. La Plata, II, p. 147 (1891).

*Panoplites*, Theo., Mon. Cul. II, p. 173 (1901).
*Mansonia*, Blanch., C.-R. Soc. Biol. LIII, p. 1046 (1901).
*Coquillettidia*, Dyar, Proc. Ent. Soc. Wash. VII, p. 47 (1905).
*Rhynchotaenia*, Brèthes, An. Mus. Buenos Ayres, XX, p. 470 (1910).
*Pseudotaeniorhynchus*, Theo., Novae Culicidae, I, p. 19 (1911).

Theobald substitutes the name *Pseudotaeniorhynchus* for those species which he formerly included in *Taeniorhynchus*, his *Panoplites* (= *Mansonia*) sinking under *Taeniorhynchus*, Arrib. But *T. fasciolatus*, Arrib., which Theobald specified as the type of his modification of Arribalzaga's genus, is quite a typical *Taeniorhynchus*, and hence *Pseudotaeniorhynchus*, Theo., is synonymous with *Taeniorhynchus*, Arrib. According to the Zoological Record for 1910, Brèthes had previously substituted *Rhynchotaenia* for *Taeniorhynchus*, Theo.; I have been unable to consult this paper.

3. **T. aurites,** Theo., Mon. Cul. II, p. 209 (1901).

*Chrysoconops fraseri*, Theo. (Novae Culicidae, I, p. 22, 1911), is a synonym.

3a. **T. microannulatus,** Theo. (*Chrysoconops*), Novae Culicidae, I, p. 26 (1911).

This is a distinct species, but closely allied to *T. aurites* from which it differs principally in the colour of the hind legs: in *T. aurites* the tibia has a median dark ring and a dark tip, the first three tarsal joints have rather broad apical dark bands, and the last two are entirely dark; in *T. microannulatus*, on the contrary, the hind tibia is entirely yellow, and the tarsal joints are only very narrowly black at the apex. In the male the palpi are entirely yellow, not spotted with black as in *T. aurites*. The oriental *T. ochraceus*, Theo., differs in having a small black ring near the tip of the hind femora, and blackish marks at the base and apex of the hind tibiae. *T. ochraceus* has been redescribed by Knab (Ent. News, 1909, p. 386) as *Mansonia chrysogona*, owing to an error in the original description, Theobald stating that the upright scales of the head are black, when actually they are yellow. The specimens recorded from Bahr-el-Jabel, Anglo-Egyptian Sudan, by Theobald, as *T. aurites* (First Rept. Wellc. Lab., p. 77) are not that species, but *T. microannulatus*.

Sudan; Uganda.

4. **T. annettii,** Theo., Mon. Cul. II, p. 205 (1901).

Add to synonymy: *Chrysoconops maculipennis*, Theo., Novae Culicidae, I, p. 27 (1911).

5. **T. cristatus,** Theo., First Rep. Wellc. Lab., p. 78 (1904).

Additional localities: Portuguese Congo (San Salvador, *Dr. M. Gamble*); Sierra Leone (*Dr. J. C. Murphy*).

6. **T. fuscopennatus,** Theo., Mon. Cul. III, p. 265 (1903).

Add to synonymy: *Chrysoconops bakeri*, Theo., Novae Culicidae, I, p. 19 (1911); *Culex grandidieri*, Blanchard, Les Moust., p. 627 (1905); and *Culex flavus*, Ventrillon, Bull. Mus. Paris, X, p. 550 (1904), (nec *C. flavus*, Motschulsky, 1859).

Ventrillon describes the dorsal surface of the abdomen as entirely yellow, but the mesonotum as brown and not black. Specimens (four ♀) answering to this description have been received from Zanzibar (*Dr. W. M. Aders*), but I do not think they are specifically distinct from *T. fuscopennatus*, in which the abdomen is banded. *T. cristatus* is distinguished from these Zanzibar examples only by its black mesonotum, and may therefore prove to be merely a variety of this species.

*Taeniorhynchus perturbans*, Walk., has been recorded as African by Laveran and Blanchard, and their records have been copied by Bezzi and Neveu-Lemaire. Reference to this species was inadvertently omitted in my previous paper, but it is very unlikely that *T. perturbans* is really an African species, since it was first described from the United States, and is now quite well known there. Prof. Blanchard and Dr. Laveran both inform me that the specimens on which the records were founded have been lost, so that there is no possibility of verifying them, but it seems quite possible that the species in question was really *Mansonioides uniformis*, especially since Dr. Laveran says it was very abundant

at Djibuti. He said it agreed with *T. perturbans* in having simple claws in the female, and basal white bands on the tarsal joints; only two African species known to me have these characters—*Howardina gebeleinensis* and *M. uniformis*, and the former is ruled out on account of its rarity.

### Genus Theobaldia, N.-L.

C. R. Soc, Biol., 1902, p. 1331.

*Culiseta*, Felt, New York State Mus. Bull. 79, p. 391c (1904).
? *Culicella*, Felt, *l.c.*
*Pseudotheobaldia*, Theo., Mon. Cul. IV, p. 271 (1907).
*Theobaldinella*, Blanch., Les Moustiques, p. 390 (1905).

The last two joints of the male palpi are about equal in length (in my previous paper it was erroneously stated that the terminal joint is "longer than the penultimate"). The third (last) joint is distinctly thicker than the second.

### Genus Culex, L.

Syst. Nat. Ed. X (1758).

*Heteronycha*, Arrib., Rev. Mus. La Plata, II, p. 56 (1891).
*Lutzia*, Theo., Mon. Cul. III, p. 155 (1903).
*Lasioconops*, Theo., Mon. Cul. III, p. 235 (1903).
*Melanoconion*, Theo., Mon. Cul. III, p. 238 (1903).
*Heptaphlebomyia*, Theo., Mon. Cul. III, p. 336 (1903).
*Trichopronomyia*, Theo., Ann. Mus. Nat. Hung., p. 98 (1905).
*Neoculex*, Dyar, Proc. Ent. Soc. Wash. VII, p. 47 (1905).
*Pseudoheptaphlebomyia*, Ventr., Bull. Mus. Paris XI, p. 427 (1905).
*Mochlostyrax*, D. & K., Journ. N. Y. Ent. Soc. XIV, p. 223 (1906).
*Jamesia*, Christophers, Sci. Mem. Med. Ind., N. S. XXV, p. 12 (1906).
*Maillotia*, Theo., Mon. Cul. IV, p. 274 (1907).
*Aporoculex*, Theo., Mon. Cul. IV, p. 316 (1907).
*Leucomyia*, Theo., Mon. Cul. IV, p. 372 (1907).
? *Microculex*, Theo., Mon. Cul. IV, p. 461 (1907).
*Oculeomyia*, Theo., Mon. Cul. IV, p. 515 (1907).

*Grabhamia* is not, as stated in my previous paper, a synonym of *Culex*; the type species, though possessing simple claws in the female and male palpi similar to those of *Culex*, has the female abdomen of the *Aëdes* type, and so *Grabhamia* must be placed near *Howardina*. Messrs. Dyar and Knab include it in *Janthinosoma*, which it closely resembles in the structure of the male palpi.

As several new species have been described or are recorded as new to the African fauna, a fresh table of species has been given, and the opportunity has been taken of including Dr. Neveu-Lemaire's species in it; although I am still unable to recognise these, they seem to be distinct, so far as can be made out from the descriptions.

1. Proboscis and tarsi with pale bands, those on tarsi including both ends of joints ... ... ... ... ... ... ... 2.
   Tarsi unbanded ... ... ... ... ... ... ... ... 9.

2. Thorax with pale scales on the anterior two-thirds, or at least with a transverse pale band behind the middle... ... ... ... 3.
Thorax almost uniformly coloured, at most with a pair of pale spots; abdominal segments with complete basal white bands ... 6.
3. Wing-scales all, or nearly all, dark; abdomen usually almost unicolorous ... ... ... ... ... ... ... ... 4.
Wings with numerous light scales; abdomen with conspicuous markings ... ... ... ... ... ... ... ... 5.
4. Femora and tibiae with rows of sharply defined white spots 1. *quasigelidus*.
Femora and tibiae marbled but not spotted ... ... 2. *consimilis*.
5. Abdominal segments with complete apical yellowish bands; wing-scales equally light and dark ... ... ... ... 3. *ager*.
Abdominal segments with both median basal and lateral apical triangular pale spots; on the wings the dark scales preponderate ... ... ... ... ... ... 4. *annulioris*.
6. Lateral dark lines on thoracic integument outwardly concave 5. *zeltneri*.
" " " " convex ... 7.
7. Middle tibiae with a whitish lateral stripe; abdominal bands broadest in middle; band of proboscis broad and ill-defined ... 6. *duttoni*.
Middle tibiae unstriped; abdominal bands of equal breadth throughout; band of proboscis narrower and more clearly defined ... 8.
8. Femora not marbled ... ... ... ... ... 7. *thalassius*.
Femora marbled ... ... ... ... ... ... 8. *somaliensis*.
9. Proboscis banded ... ... ... ... ... 9. *ataeniatus*.
Proboscis unbanded (but compare *C. tigripes* and *C. univittatus*, both of which sometimes show traces of a median pale band on the proboscis) ... ... ... ... ... ... ... ... 10.
10. Thorax with four well-defined silvery spots ... 10. *argenteopunctatus*.
Thorax without silvery spots ... ... ... ... ... ... 11.
11. Large species; femora and tibiae spotted ... ... ... 11. *tigripes*.
Medium-sized species; legs not spotted (except sometimes in *tipuliformis*)... ... ... ... ... ... ... ... 12.
12. Legs somewhat striped as in *Ochlerotatus ochraceus* (on the fore leg the pale stripe is more or less broken up into spots, recalling *C. tigripes*) ... ... ... ... ... ... 12. *tipuliformis*.
Legs not so marked ... ... ... ... ... ... ... 13.
13. Tibiae striped with whitish, much as in *C. duttoni*; "seventh vein" more distinct than usual, and generally bearing a few scales 13. *univittatus*.
Legs uniformly brownish or yellowish (except for pale knee-spots)... 14.
14. General coloration tawny; proboscis clear yellow; legs tawny 14. *pygmaeus*.
Proboscis and legs dark brown or blackish ... ... ... ... 15.
15. Abdominal segments with pale markings basally ... ... ... 16.
Abdominal segments with pale markings apically (sometimes hardly perceptible) ... ... ... ... ... ... ... ... 24.

16. Abdominal segments with basal banding in both sexes (in *C. decens* ♀ the pale bands are often very narrow) ... ... ... ... 17.
Abdominal segments with basal lateral pale spots, in the ♂ often united in the middle forming an irregular shaped band ... ... 19.
17. Larger species; abdominal bands yellowish; a line of white scales on the under side of the last two joints of the male palpi 15. *pipiens* group.
Smaller species; abdominal bands white ... ... ... ... 18.
18. Thoracic scaling uniformly reddish brown, ♂ palpi all dark 16 *decens.*
Thoracic scaling partly bronzy-brown and partly brassy, the latter often predominating; male palpi as in *C. pipiens* 17. *simpsoni.*
19. Thorax all pale-scaled, integument with lateral pale areas in front; abdominal spots large in both sexes ... ... ... 18. *pruina.*
Thorax not all pale-scaled, integument uniformly dark ... ... 20.
20. Thorax with two distinct pale areas near the middle...19. *ornatothoracis.*
Thorax with uniform scaling or nearly so ... ... ... ... 21.
21. Venter entirely whitish ... ... ... ... ... ... 20. *guiarti.*
Venter with dark bands on the apices of the segments ... ... 22.
22. Bases of fork-cells in ♀ equidistant from wing base ... 21. *grahami.*
Base of first fork-cell nearer wing-base than that of second... ... 23.
23. Larger species (usual 5–6 mm.); thorax with reddish brown scales (intermediates seem to occur between this and some of the *C. pipiens* group) ... ... ... ... ... 22. *zombaensis.*
Smaller species (usually 3–4 mm.); thorax with dark brown scales (compare with *C. guiarti;* both often have a green thorax) 23. *invidiosus.*
24. Abdomen with complete apical bands on at least some of the segments 25.
Abdomen with apical lateral spots ... ... ... ... ... 27.
25. Terminal joint of ♀ palpi short and thick ... ... 24. *salisburiensis.*
Terminal joint of ♀ palpi long and thin ... ... ... ... 26
26. Abdominal segments 2–7 with apical pale bands ... ...25. *piliferus.*
Abdominal segments 2–5 ,, ,, ... ... 26. *insignis.*
27. Thoracic integument black, scales black or blackish... ... 27. *rima.*
Thoracic integument reddish ... ... ... ... ... ... 28.
28. Scales and bristles of thorax reddish brown ... ... ...28. *sergenti.*
Scales and bristles of thorax black ... ... ... 29. *rubinotus.*

1. **C. quasigelidus,** Theo., Mon. Cul. III, p. 181 (1903).

Add to synonymy: *Culex par*, Newst., Ann. Trop. Med. I, p. 25 (1907).

The leg-spots are quite distinct. The front of the mesonotum is whiter than usual.

Additional locality: Gold Coast.

2. **C. consimilis,** Newst., Ann. Trop. Med. I, p. 23 (1907).

Additional localities: Brit. E. Africa (*T. D. Nair*); Gold Coast (*Dr. A. Ingram*).

This species seems to be variable; or there may be more than one here. Some specimens show narrow basal bands, others distinct apical lateral spots, on the abdominal segments; but the wing-scales are never mottled, and the ornamentation of the abdomen, when present, never has any resemblance to that found in the next two species.

3. **C. ager**, Giles, Entomologist, XXXIV, p. 196 (July, 1901).

My statement that this is not an African species proves to be incorrect. A single male specimen from Maiduguri, N. Nigeria, June, 1911 (*Dr. W. D. Inness*) is *C. ager*; and a series has been bred from larvæ from Bole, Gold Coast (*Dr. A. Ingram*). It differs from *C. consimilis* (1) in having broad distinct *apical* pale bands on the abdominal segments, as well as a pale basal band on segment 8; (2) in the strongly marbled wings.

To the synonymy previously given for this species may be added: *Culex infula*, Theo., Mon. Cul. I, p. 370 (1901).

Between the African specimens and those in the British Museum from the Oriental region there are slight but seemingly constant differences. However, the description of *C. ager* given by Dr. Leicester applies quite well to the African form, and as the resemblances are so great, and the species in the Oriental region is undoubtedly variable, it is considered unwise to regard these specimens as representing a distinct species. They may, however, be given a varietal name, the variety being characterised as follows:—

*Culex ager*, var. *ethiopicus*, nov. Resembles the type in most respects, but (1) there is no pale spot at the apex of the proboscis above, as nearly always is the case in Oriental specimens; (2) the wing scales are larger, broader and

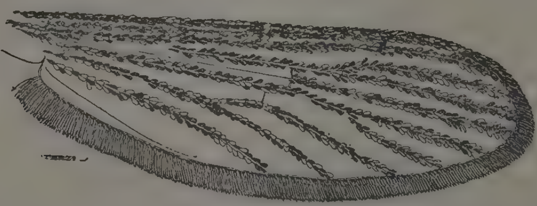

Fig. 5.—*Culex ager*, Giles, var. n. *ethiopicus*. In some specimens many of the scales on the forked veins are rather narrower than those shown in the figure.

denser, the light ones being quite as numerous as the dark (in the type form they are *usually* less numerous); (3) the bands on the abdomen are a lighter yellow. In some specimens the thorax shows a distinct green colour, as is so often the case in freshly hatched specimens. The lateral vein-scales vary somewhat in breadth.

4. **C. annulioris**, Theo., Liverp. S. Trop. Med., Mem. IV, App. p. v (1901).

*Culex neireti*, Ventrillon, Bull. Mus. Paris, XII, p. 103 (1906).

Additional locality: Gold Coast (Bole, *Dr. Ingram*); Madagascar (*Dr. Ventrillon*).

5. **C. zeltneri,** N.-L., Arch. Parasit. X, p. 251 (1906).

This species seems to differ from *C. thalassius* in the ornamentation of the mesothoracic integument. Judging from M. Neveu-Lemaire's figure, the median pair of dark lines are less distinct and closer together, while the broader lateral dark lines are concave outwardly, instead of convex as in most other species of *Culex*.

Abyssinia.

6. **C. duttoni,** Theo., Rept. Liverp. S. Trop. Med., Mem. V, App. p. v (1901).

Additional locality : Uganda.

9. **C. ataeniatus,** Theo., U. South Afr. Dept. Agric., First Rept. Vet. Res., p. 261 (1911).

Described as "Proboscis dark at base and apex, dull ochraceous in the middle, forming a broad pale band . . . abdomen brown with narrow basal pale bands . . . legs brown, unbanded . . . Length 3 mm. . . . A single perfect female. At once told from all other *Culex* by the banded proboscis and unbanded legs." I suspect this may be a variety of *C. univittatus*.

Transvaal.

10. **C. argenteopunctatus,** Ventr. (*Heptaphlebomyia*), Arch. Parasit. IX, p. 446 (1905).

This species is remarkably distinct from all other species of *Culex* known to me on account of the four silvery spots on the mesonotum, recalling to some extent *Ochlerotatus punctothoracis*. In the present species, however, these spots, and a broad silvery margin to the eyes, are composed of narrow curved scales; the scutellum also is clothed with similar scales. The general coloration is greyish brown; there is a distinct white spot at the apex of the hind tibia, and basal lateral white spots on the abdominal segments.

Dr. A. Ingram has bred 2 ♀ at Bole, Northern Territories, Gold Coast. Previously the species has only been recorded from Madagascar.

12. **C. tipuliformis,** Theo., Mon. Cul. II, p. 325 (1901).

This, I find, is an older name for the species previously dealt with as *C. theileri*, Theo. Additional synonyms are *C. creticus*, Theo. (Mon. Cul. III, p. 189, 1903) and *C. onderstepoortensis*, Theo. (U. South Afr. Dept. Agric., First Rept. Vet. Res., p. 265, 1911). I found the type of *C. creticus* in a pill-box on the lid of which was written "*Culex cretinus*, n. sp.," but no locality. There is little doubt that it is only a pale specimen of *C. tipuliformis*; the leg-markings do not differ in the way indicated in the description, nor, apparently, in any other way. *C. onderstepoortensis* is described as "Related to *Culex theileri*, but easily told by the pale-scaled head and thorax." The scales of the head and thorax of the type (in the British Museum) are not paler than in typical *C. theileri*.

The cross-veins of this species are somewhat approximated, and on this account Messrs. Dyar and Knab would place it in *Culiseta* (= *Theobaldia*); but the male palpi are of typical *Culex* structure.

Additional locality : British East Africa.

13. **C. univittatus**, Theo., Mon. Cul. II, p. 29 (1901).

Add to synonymy :

*Culex perexiguus*, Theo., Mon. Cul. III, p. 199 (1903).

*Culex goughii*, Theo., U. South Afr. Dept. Agric., First Rept. Vet. Res., p. 268 (1911) (♀ only).

*C. goughii* is described as " A rather obscure species of *fatigans* type, but can be easily told in both sexes by the white scaled line on the palpi, which is ventral and very marked in the male." This white-scaled line on the under side of the last two joints of the male palpi is characteristic of the *pipiens* group of species, and occurs in a modified form in *C. univittatus*. In every one of 380 males of *C. pipiens*, *C. fatigans*, etc., examined by the writer, this character was present and showed no variation. The male type of *C. goughii* is a typical *C. pallidocephalus*.

Additional localities: Palestine (*C. perexiguus*); S. Spain, four typical specimens in British Museum (*Major P. Fowler*, July, 1909); Mauritius; Sudan; Gambia; S. Nigeria; Gold Coast; N.E. Rhodesia; Brit. E. Africa; British Central Africa; Transvaal; Natal. One specimen from Salisbury, S. Rhodesia (*G. A. K. Marshall*) appears to belong to this species, yet lacks the most striking feature—the tibial stripe. This specimen superficially much resembles *Ochlerotatus quasiunivittatus*. One or two specimens sent by Dr. Ingram, from the Gold Coast, show traces of a pale band on the proboscis, more especially on the under surface, quite half of which is dull ochreous. This is another point of resemblance to *C. duttoni*, but the two are quite distinct. The larva of *C. duttoni* has a thick, swollen air-tube, rather like that of a *Janthinosoma*; while in *C. univittatus* the air-tube is long and thin, as in most species of *Culex*.

14. **C. pygmaeus**, N.-L., Arch. Parasit. X, p. 256 (1906).

" Espèce de petite taille à coloration générale fauve . . . Trompe jaune . . . Pattes fauves . . . Abdomen brun, annelé de jaune à la base des segments." The species is a true *Culex*, and from the above statements would seem to be well distinguished from other African forms, notably by the yellow proboscis.

Abyssinia (Imi, *Brumpt*).

15. **C. pipiens**, L., etc.

Messrs. Dyar and Knab distinguish several American species in this group by means of the basal parts of the male genitalia. They consider *C. fatigans*, Wied., to be a synonym of *C. quinquefasciatus*, Say. It is very likely that a careful study of the male genitalia of African specimens would enable one or two forms to be properly separated from *C. pipiens*, but this does not seem possible on external characters. I am inclined to think that *C. pallidocephalus* (= *stoehri*) may be distinct from *C. pipiens*; the thorax is a good deal darker and shows indistinct lines of pale scales, somewhat as in *O. dentatus*. When I sank this as a variety of *C. pipiens* I had seen only two or three specimens; a number of others have now been received.

*C. didieri*, N.-L. (Arch. Parasit. X, p. 257, 1906), apparently belongs to the *pipiens* group.

16. **C. decens**, Theo., Rept. Liverp. S. Trop. Med., Mem. IV, App. p. vii (1901).

Additional locality: Gold Coast.

17. **C. simpsoni,** Theo., J. Econ. Biol. I, p. 28 (1905).
Additional locality : British East Africa (Masongoleni, *S. A. Neave*).

18. **C. pruina,** Theo., Rept. Liverp. S. Trop. Med., Mem. IV, App. p. viii (1901).
Additional locality : Sierra Leone (Daru, *Dr. J. C. Murphy*).

20. **C. guiarti,** Blanch., Les Moustiques, p. 629 (1905).
*C. laurenti*, Newst. (Ann. Trop. Med., I, p. 24, 1907), is synonymous. The lateral whitish spots on the abdomen are folded inwards, and so not visible till the specimen is carefully examined. The colouring of the femora agrees with that of the type of *C. guiarti.*
Additional localities : S. Nigeria ; Nyasaland.

23. **C. invidiosus,** Theo., Mon. Cul. II, p. 329 (1901).
Additional locality : Nyasaland.

25. **C. piliferus,** Theo., Mon. Cul. IV, p. 274 (1907).
This is closely allied to the European *C. geniculatus*, Olivier (which probably has nothing to do with *C. hortensis*, Ficalbi), and the North American *C. apicalis*, Adams. Possibly all three may be varieties of the same species.

26. **C. insignis,** Carter, Bull. Ent. Res. II, p. 37 (1911).
Additional locality : Lagos (*Dr. W. H. Sieger*). Usually the fifth abdominal segment has a pale apical band, as well as the second, third and fourth.

### Genus PROTOMELANOCONION, Theo.

Mon. Cul. V, p. 462 (1910).

1. **P. fuscum,** Theo., Mon. Cul. V, p. 463 (1910).
This species, or one extremely similar, occurs in India under the name of *Stegomyia brevipalpis*, Giles. There are six specimens in the British Museum labelled "*Stegomyia brevipalpis*, type, G. M. Giles"; of these, three ♀♀ are *Steg. microptera*, Giles, two more (♀) represent two indeterminable species of *Culex*, while the sixth, a male, agrees with Giles' description and figure of *S. brevipalpis*. So far as I can see it only differs from *P. fuscum* ♂ in having the fore and mid claws (at least the larger one) minutely toothed. Thus this genus must rest entirely on the structure of the male palpi, the apical joint of which is almost as short as in *Mansonioides*.

### Genus CULICIOMYIA, Theo.

Mon. Cul. IV, p. 227 (1907).

*Trichorhynchus*, Theo., J. Bomb. Nat. Hist. Soc. p. 240 (1905), (*nec Trichorhynchus*, Balbiani, 1887).
*Neomelanoconion*, Theo., Mon. Cul. IV, p. 514 (1907).
*Pectinopalpus*, Theo., Ann. Mag. Nat. Hist. (8) V, p. 375 (1910).

The type species of *Trichorhynchus* (*T. fuscus*) and of *Culiciomyia* (*C. inornata*), are, I find, synonymous. Fortunately, however, Theobald's *Trichorhynchus* is preoccupied by a genus of Protozoa, and so there is no need to change

the name of the African species. Although *Culiciomyia* does not seem to differ structurally from *Culex*, it is perhaps worth while retaining it as a separate genus, since the group can be fairly easily recognised on scale characters. It should, however, be noticed that in *Culex annulirostris* (and *C. somaliensis* and *C. microannulatus*, both perhaps forms of *C. annulirostris*) the male palpi have a row of white translucent *hairs* in the same position as the similar *scales* of *Culiciomyia*.

1. **C. nebulosa,** Theo., Rept. Liverp. S. Trop. Med., Mem. IV., App., p. x. (1901).

*Culex fragilis*, Ludl., J. N. Y. Ent. Soc. p. 142 (1903).

A specimen in the British Museum named *Culex fragilis* is undoubtedly only *C. nebulosa*. Hence this species, like *B. luteolateralis*, extends its range into the Philippine Islands.

### Genus Eumelanomyia, Theo.

Mon. Cul. V, p. 240 (1910).

Resembles *Culex* in most essentials; the male palpi are somewhat shorter than the proboscis, of uniform thinness and almost devoid of long hairs; there is a large area of flat scales over the top of the head. From *Culiciomyia* this genus can be distinguished by the shorter male palpi, which lack the characteristic row of outstanding scales, and by the more extended flat-scaled area on the head.

1. **E. inconspicuosa,** Theo., Mon. Cul. V, p. 240 (1910).

A medium-sized blackish species, with small lateral, apical pale spots on the abdominal segments, and a pale venter.

Ashanti; Gold Coast (Bibianaha, *Dr. H. G. F. Spurrell*); Sierra Leone (Daru, *Dr. J. C. Murphy*).

### Genus Micraëdes, Coq.

Proc. Ent. Soc. Wash. VII, p. 185 (1905).

1. **M. (?) inconspicuosus,** Theo. (*Aëdes*), Entomologist, XLI, p. 109 (1908).

This is a small brown mosquito, 3 mm. in length, and without close examination might be mistaken for a *Uranotaenia* or an *Ingramia*, but the proboscis is not swollen at the tip, the fork-cells are longer, and the lateral vein-scales narrow.

The genus *Micraëdes* was founded by Coquillett for a single North American species, *M. bisulcatus*, which has the palpi one-third the length of the proboscis in both sexes, and a tooth on one claw of the fore and mid legs of the male. This African species does not quite agree with Coquillett's diagnosis, as the palpi are barely one-sixth the length of the proboscis in both sexes, and all the claws are simple (those on the fore and mid legs of the male being unequal); as, however, the species fits better into *Micraëdes* than any other genus, I have included it here rather than create a new genus for it on very slight characters.

S. Nigeria (Lagos, *Dr. Graham*); Congo (Coquilhatville, *Dr. A. Yale Massey*); Uganda (*Capt A. D. Fraser*); Transvaal.

Leicester (Stud. Inst. Med. Res., Fed. Malay States, III, iii, p. 184) describes a very similar species as *Aëdes malayi*, and remarks concerning it, " This genus is

closely related to *Culex* and *Melanoconion* on the one hand and less so to *Aioretomyia* [= *Aëdes.*—F.W.E.] amongst the AEDEOMYINAE. In fact nothing could better shew how unscientific is a classification based on palpi than that genera so closely related as *Culex*, *Melanoconion* and *Aëdes* should be placed in different [sub-] families." These remarks are interesting, though Dr. Leicester has wrongly interpreted the genus *Aëdes*.

### Genus HODGESIA, Theo.

J. Trop. Med. VII, p. 17 (1904).

Till recently this genus was only known from females, but Dr. Leicester claims to have found the male of one of the species he describes from Malaya (*H. malayi*, *op. cit.* p. 231). He says it is much smaller than the female, but otherwise very difficult to distinguish from it, as the genitalia are almost hidden, the palpi very short (apparently one-jointed), and the antennae pilose as in the female. In both sexes these insects can be distinguished from other CULICIDAE by the apically dentate wing-scales. There are five species described, two from Africa, two from Malaya and one from the Philippine Is. They are minute black insects with silvery markings on the head, prothoracic lobes and sides and venter of the abdomen.

1. **H. sanguinis**, Theo. (*sanguinae*), J. Trop. Med. VII, p. 17 (1904).
Tarsi normal.
Uganda ; Congo ; S. Nigeria.

2. **H. cyptopus**, Theo. (*cuptopous*), Mon. Cul. V, p. 545 (1910).
Fourth tarsal joint on fore and mid legs with a tuft of long scales, fifth bent at an angle with the fourth.
Ashanti.

### Genus MIMOMYIA, Theo.

Mon. Cul. III, p. 304 (1903).

*Boycia*, Newstead, Ann. Trop. Med. I, p. 33 (1907).
*Ludlowia*, Theo., Mon. Cul. IV, p. 193 (1907).
*Megaculex*, Theo., Mon. Cul. IV, p. 282 (1907).
*Radioculex*, Theo., Rec. Ind. Mus. II, p. 295 (1908).
*Conopomyia*, Leicester, Stud. Inst. Med. Res., Fed. Malay States, III, iii, p. 113 (1908).
*Hispidimyia*, Theo., Mon. Cul. V, p. 245 (1910).

On examination I found that the single specimen (female) of *Mimomyia splendens* in the British Museum collection possesses all the characters of *Ludlowia*, even to the long bristles on the leg, while the remaining species of *Mimomyia*, Theo., seemed to belong to a quite distinct genus. Subsequent events supported this conclusion, for in a large collection just received by the Entomological Research Committee, from Dr. Ingram of the Gold Coast, is a good series of bred specimens of *M. splendens*, the males having the two-jointed apically swollen palpi characteristic of this genus. As *M. splendens* is the type species of *Mimomyia* it becomes necessary to sink *Ludlowia*

under *Mimomyia*, while the new genus *Ingramia* has had to be erected for those species which were formerly included with *M. splendens* in *Mimomyia*. To the characters already given (Bull. Ent. Res. II, p. 244, under *Ludlowia*) may be added the structure of the eighth abdominal tergite in the female. This is narrower and more pointed than in *Culex*, though not nearly so narrow as in *Ochlerotatus*, and is of uniform shape throughout the genus (*see* fig. 1, *C*). The basal segment of the female antennae is hairy on the inside; the second segment is variable in length, but always longer than the third.

In my previous paper (Bull. Ent. Res., Oct. 1911), reference to *Ludlowia sudanensis*, Theo., was accidentally omitted; it was described from a single male mounted in balsam, which is said to be, but is not, in the British Museum collection. As the ungues are described as "apparently all equal and simple," its location in this genus must be regarded as doubtful until more material is obtained. Dr. Ingram has performed the remarkable feat of breeding all the African species, except the doubtful *M. sudanensis*. None of the larvae were previously known.

A fresh table of the species is given.

1. Head flat-scaled in middle; end of hind tarsi not white (sub-genus *Mimomyia*) ... ... ... ... ... ... ... ... 2.
   Head not flat-scaled in middle; end of hind tarsi white (sub-genus *Megaculex*) ... ... ... ... ... ... ... ... 3.
2. Scales of mesonotum bright green, sub-metallic ... ... 1. *splendens*
   Scales of mesonotum blackish brown or yellowish brown ... 2. *hispida*.
3. Large species (6–8 mm.) ... ... ... ... ... 3. *plumosa*.
   Small species (3–4 mm.) ... ... ... ... ... ... 4.
4. Last $2\frac{1}{3}$ joints of hind tarsi whitish ... ... ... 4. *mimomyiaformis*.
   "Three last hind tarsals pale yellow;" "male ungues all apparently equal and simple" ... ... ... 5. *sudanensis*.

1. **M. splendens**, Theo., Mon. Cul. III, p. 304 (1903).

This is one of the most striking and beautiful of all the African Culicidae; the brilliant green scales contrast strongly with the shiny black integument of the thorax and make it an extremely well-marked species. The legs are mainly golden yellow, but bear numerous purple scales, especially at the tips of the femora, and the apical fourth of the hind tibiae is conspicuously black and somewhat swollen. There are traces of basal pale bands on some of the joints of the tarsi, which are mainly brownish. Length 3 mm., without the proboscis. Second joint of female antennae $1\frac{1}{2}$ times as long as third.

Uganda; Sudan; Gold Coast.

2. **M. hispida,** Theo. (*Hispidimyia*), Mon. Cul. V, p. 245 (1910).

*Ludlowia hispida*, Edw., Bull. Ent. Res. II, p. 245 (1911).
*Megaculex palustris*, Theo., Novae Culicidae, I, p. 13 (1911).

This is a variable species, and it is possible that there may be two or more included under the same name, but I do not think so. The abdomen may be all purple, entirely unbanded, or with distinct basal lateral spots, or with entire basal yellow bands. That these are not specific differences is shown by the fact that

in Dr. Ingram's series bred from the same lot of larvae one specimen has a banded abdomen, the rest showing only the lateral spots to a variable extent. Usually the second joint of the female antennae is $2\frac{1}{2}$ times as long as the third (*M. hispida*, type), but in some specimens quite three times as long (*M. palustris*, type). The mesonotum is usually clothed with blackish brown scales and black bristles, but the bristles are sometimes yellow and the dark scales seem replaceable by yellowish ones. The metanotum may be all yellowish, or with a dark line down the middle (*M. hispida*, type), or entirely dark (*M. palustris*, type).

Uganda ; Sudan ; Gold Coast.

3. **M. plumosa**, Theo. (*Culex*), Mon. Cul. I, p. 373 (1901).
   *Megaculex albitarsis*, Theo., Mon. Cul. II, p. 25 (1901).
   *Ludlowia plumosa*, Edw., Bull. Ent. Res. II, p. 245 (1911).

Second segment of female antennae $2\frac{1}{2}$ or 3 times as long as third.

S. Nigeria ; Gold Coast ; Congo ; Uganda ; Mashonaland.

4. **M. mimomyiaformis**, Newst. (*Boycia*), Ann. Trop. Med. I, p. 34 (1907).
   *Megaculex pincerna*, Graham, Ann. Mag. Nat. Hist. (8) V, p. 267 (1910).
   *Ludlowia pincerna*, Edw., Bull. Ent. Res. II, p. 245 (1911).

On comparing the types of *B. mimomyiaformis* and *M. pincerna* I find them to be the same. The former has only the last $2\frac{1}{3}$ joints of the hind tarsi pale, and the pale spots on the tarsal articulations are present though faint.

Second joint of female antennae $1\frac{1}{3}$ times the length of the third, and rather swollen.

N. and S. Nigeria ; Gold Coast ; Congo.

5. **M. sudanensis**, Theo. (*Ludlowia*), Mon. Cul. IV, p. 195 (1907).

I rather strongly suspect that this is really the same as the last species ; in any case the claws are probably *not* "all equal and simple." One specimen in Dr. Ingram's series of *M. hispida* shows the ♂ palpi bent exactly as figured by Theobald (First Rept. Wellc. Lab. p. 83, where the species was not named), and this condition is evidently only due to shrinkage.

Sudan.

## Genus Uranotaenia, Arribalzaga.

Rev. Mus. La Plata II, p. 163 (1891).

*Pseudouranotaenia*, Theo., J. Econ. Biol. I, p. 33 (1905).
*Anisocheleomyia*, Theo., Entomologist, XXXVIII, p. 52 (1905).
*Pseudoficalbia*, Theo., U. South Afr. Dept. Agric., First Rept. Vet. Res., p. 272 (1911) (*nom. nud.*) ; id., Trans. Linn. Soc. Lond. XV, 1, p. 89 (1912).

This genus is quite an easy one to recognise. The most marked feature is found in the short fork-cells, the first being slightly or considerably shorter than the second. The head is always flat-scaled, and also the scutellum ; the proboscis is slightly swollen at the tip in the female, distinctly so in the male ; the middle femora are swollen near the base (but this is the case in many other mosquitos) The species are all small (2–3 mm. in length) and frequently have blue markings on

the head and thorax, the blue in some species being replaceable by whitish, probably owing to fading after death. The thorax is short and rounded. The claws of the male give another marked generic character, which will at once distinguish *Uranotaenia* from all other CULICIDAE. On the front legs the claws are *small and equal in length*, though the inner one is often broader than the outer; on the mid legs there is one small and one large claw, the large one falcate; on the hind legs both claws are small and equal. In the second volume of his Monograph, Theobald gives figures which purport to be the claws of the front legs of *U. annulata* (p. 251), *U. mashonaensis* (pp. 260, 261) and *U. alba* (p. 262). In each case, as I have proved by examining the types, these figures portray not the front but the middle claws of the male. Again, Theobald states (Mon. Cul. IV, p. 565) that the fore ungues of *U. geometrica* are unequal; this also is incorrect. All the claws are simple in both sexes. The fore claws of the female are sometimes (? always) like those of the male—one being broad, and it was on account of this circumstance that Theobald introduced the genus *Anisocheleomyia*. In all his three species (*A. nivipes*, *A. alboannulata* and *A. leucoptera*), each of which was described as from one or two males, the types are in reality females.

*Table of the species.*

| | | |
|---|---|---|
| 1. | Thorax with a whitish or blue line in front of the base of the wings composed of flat scales ... ... ... ... ... ... | 2. |
| | Thorax without such line: no flat scales on mesonotum (*Pseudoficalbia*, Theo.) ... ... ... ... ... ... ... | 10. |
| 2. | Hind tarsi with distinct whitish bands, last two joints white ... | 3. |
| | Hind tarsi unbanded ... ... ... ... ... ... ... | 4. |
| 3. | Abdomen unbanded ... ... ... ... ... ... | 1. *bilineata*. |
| | Abdomen with basal yellowish bands on all the segments... | 2. *connali*. |
| 4. | Some at least of the abdominal segments bearing distinct pale bands ... ... ... ... ... ... ... ... | 5. |
| | Abdomen unbanded, though there may be small pale apical lateral spots on all the segments ... ... ... ... ... ... | 7. |
| 5. | Segments 2 and 4 only with pale apical bands ... ... | 3. *alba*. |
| | Segments 1–4 pale apically, or entirely pale ... ... ... | 6. |
| 6. | Segments 6 and 7 with pale basal bands; 1–4 nearly all pale-scaled ... ... ... ... ... ... | 4. *alboabdominalis*. |
| | Segments 6 and 7 with pale apical lateral patches; a white line on the mid and hind femora ... ... ... ... ... | 5. *mayeri*. |
| 7. | Pleurae with a distinct narrow line of bluish white scales | 1. *bilineata* var. *fraseri*. |
| | Pleurae without such line ... ... ... ... ... ... | 8. |
| 8. | Median area of head with black scales; male legs normal | 6. *balfouri*. |
| | Flat scales of head all blue or whitish blue... ... ... ... | 9. |
| 9. | A bluish median line on the posterior half of the mesonotum; legs of male very peculiar, the metatarsus on the anterior pairs being shorter than the following joint ... ... ... | 7. *pallidocephala*. |
| | No median bluish line on thorax (1 ♀ only known) | 8. *coeruleocephala*. |

10. Lower half of pleurae pale yellowish, sharply contrasting with upper half and mesonotum, which are deep brown ; hind tarsi with the last two joints whitish ... ... ... ... ... 11.
Integument of pleurae more or less unicolorous, and not contrasting with the mesonotum ; hind tarsi all dark ... ... ... 12.
11. Head scales light brown ; white rings embracing the articulations of the first, second and third joints of the hind tarsus 9. *annulata.*
Head scales dark brown, no pale rings on basal joints of hind tarsi 10. *candidipes.*
12. Mesonotum all brown or dark brown ... ... ... ... 13.
Mesonotum at least partly yellow ; pleurae yellow, sharply contrasting with the black legs ; head scales all deep black ... 14.
13. A spot of flat blue scales on the pleurae ; similar scales on the prothoracic lobes ... ... ... ... ... ... 11. *fusca.*
No flat scales on thorax, but a black spot on the integument just in front of each wing base ... ... ... 12. *mashonaensis.*
14. Posterior half of mesonotum mainly brown ... ... 13. *ornata.*
Posterior half of mesonotum mainly yellow... ... ... 14. *nigripes.*

1. **U. bilineata,** Theo., Mon. Cul. V, p. 517 (1910).

This is a very distinct species, being, with *U. connali*, the only African species with a white line on the pleurae and banded hind tarsi. *U. connali*, indeed, may eventually prove to be only a well-marked variety of *U. bilineata*, but as the material is so scanty it is described provisionally as distinct. Both have the first longitudinal vein clothed with white scales to the middle, a character possessed by none of the other species.

*U. bilineata*, var. *fraseri*, nov. Two females from Mpumu Forest, Uganda (*Capt. A. D. Fraser*), were at first thought to represent a distinct species, as the legs appeared to be unbanded, and there are faint traces of basal pale bands on the fifth, sixth and seventh abdominal segments. However, a close examination in a good light revealed traces of the same leg-banding as is present in *U. bilineata*, and as these specimens are quite typical in other respects, they must be regarded as only a variety of the present species. Specimens of the typical form have been received from the same place.

Ashanti ; Uganda.

2. **U. connali,** sp. n.

♂ ♀. *Head* clothed with dark, fuscous brown, flat scales in the middle, with a rather narrow margin of whitish blue flat scales ; two or three very long, whitish blue scales project over the front ; a row of black upright forked scales round the edge of the dark area, and a few more on the nape. Proboscis, palpi and antennae brown. *Thorax:* mesonotum dark reddish brown, clothed with dark brown scales, those on the scutellum flat ; a row of large flat bluish white scales extending forwards from the wing-base for half the length of the thorax ; pleurae dark brown, with a median longitudinal line of flat bluish white scales ; this line extends across the prothoracic lobes ; a few similar scales above the bases of the coxae. The integument bordering both these lines is darkened. Metanotum

dark reddish brown. *Wings* with brown-scaled veins, except the first longitudinal, which is clothed with white scales as far as the middle of the wing. First fork-cell two-thirds as long as second. Halteres with a dark brown knob, stem paler. *Legs* dark brown, femora paler beneath. Fore and mid legs with faint indications of pale spots on the articulations ; hind legs with a yellowish knee-spot ; distinct yellowish bands at the apex of the tibia and on the articulations of the first three tarsal joints ; the apex of the third and the whole of the fourth and fifth tarsal joints yellowish. Claws of typical *Uranotaenia* structure. *Abdomen* dark brown, with yellowish basal bands, broadening out in the middle, on all the segments ; seventh segment with a whitish apical lateral spot ; venter pale ochreous. *Length* 2·5 mm., without the proboscis.

*Types* in the British Museum (presented by the Entomological Research Committee).

Described from one male and one female taken in latrines at Accra, Gold Coast, by *Dr. A. C. Connal ;* the male at 1 p.m., 2. v. 1911, the female at 8 a.m., 23. iv. 1911.

Closely allied to *U. bilineata ;* distinguished by the presence of pale bands on the abdomen.

Fig. 6.—*Uranotaenia connali*, sp. n. Head and thorax of male.

3. **U. alba,** Theo., Mon. Cul. III, p. 303 (1903).

*U. mashonaensis*, var. *alba*, Theo., Mon. Cul. II, p. 262 (1901).

Known only from a single male, which differs from the following in the markings of its abdomen. The sixth and seventh segments are unbanded ; the second and fourth with pale apical patches. It is only provisionally regarded as a distinct species from *U. alboabdominalis.* The specimen is much rubbed.

S. Rhodesia.

4. **U. alboabdominalis,** Theo., Mon. Cul. V, p. 508 (1910).

The first longitudinal vein is white-scaled at the base. In the types the head is entirely blue-scaled, and the four basal segments of the abdomen are entirely whitish, but in some specimens from Uganda the head is black-scaled in the middle, and the first four abdominal segments have only apical whitish bands.

Sudan ; Uganda.

5. **U. mayeri,** sp. n.

♀. *Head* as in *U. connali*, but the pale margin narrower. *Thorax* as in *U. connali. Wings* with brown-scaled veins ; extreme base of the fourth and a short space of the fifth vein clothed with white scales. Halteres light ochreous

brown, knob dark brown. *Legs* dark brown, femora lighter beneath; mid and hind femora with a line of white scales in front; tips of hind femur and tibia black. *Abdomen* dark brown, segments 1–4 with median, 5–7 with lateral apical whitish patches; venter not visible. *Length* 2·5 mm., without proboscis.

*Type* in the British Museum (presented by the Entomological Research Committee).

Described from two females: Type, taken in house, 8. x. 1910, at Oshogbo, S. Nigeria (*Dr. T. F. G. Mayer*); a second specimen from Accra, Gold Coast (*Dr. A. C. Connal*), taken in latrine, 7 a.m., 6. v. 1911.

Differs from *U. alboabdominalis* in the presence of a white line on the mid and hind femora, and in the absence of basal pale bands on the sixth and seventh abdominal segments.

6. **U. balfouri**, Theo., First Rep. Wellc. Lab., p. 82 (1905).

The smallest species of the genus in Africa, measuring only 2 mm. in length. The abdominal segments have pale apical lateral spots, more distinct in some specimens than in others. As in the two following species, the *fifth* (*not* fourth) longitudinal vein is white-scaled towards the base.

Sudan; Gambia; S. Nigeria; Gold Coast.

7. **U. pallidocephala**, Theo., Third Rep. Wellc. Lab., p. 266 (1908).

*Uranotaenia pallidocephala* var. *coerulea*, Theo., *l.c.*, p. 267.
„ *similis*, Theo., *l.c.*, p. 257 (*nom. nud.*).
„ *abnormalis*, Theo., Mon. Cul. V, p. 512 (1910).

This species is remarkably distinct in the male sex, on account of the most extraordinary structure of the legs, which has been well described and figured by Theobald (Mon. Cul. V, pp. 512–516). It is strange that he overlooked these peculiarities in the male of *U. pallidocephala*, for the type male of that species is indistinguishable from *U. abnormalis*. In the Uganda specimens the median posterior pale line of the thorax is sometimes indistinct. The claws are quite normal.

Sudan; Uganda.

8. **U. coeruleocephala**, Theo., Mon. Cul. II, p. 256 (1901).

This species is represented in the British Museum collection by a single female (type). The male described by Theobald (Mon. Cul. III, p. 302) as the male of this species is really *U. balfouri*. *U. coeruleocephala* seems very near *U. pallidocephala*, and it would be interesting to know if the male has the same peculiarities; if so, the two could hardly be regarded as distinct species.

S. Nigeria. Theobald also records it from Uganda.

9. **U. annulata**, Theo., Mon. Cul. II, p. 250 (1901).

*Uranotaenia apicotaeniata*, Theo., Mon. Cul. V, p. 520 (1910).

This species is sharply distinguished from all the others by the character given in the key, the dark upper half of the pleurae being concolorous with the integument of the mesonotum. In describing *U. apicotaeniata* Theobald did not notice

that the pleurae were partly dark, but this is the case in the types. There are no white scales on the wing-veins.

Gambia; S. Nigeria; Ashanti.

10. **U. candidipes**, nom. n.

*U. nivipous*, Theo., Entomologist XLV, p. 93 (1912),—*nec U.* (*Anisochelcomyia*) *nivipes*, Theo., Entomologist, XXXVIII, p. 53 (1905).

"♀. Head deep brown, with golden forked scales; palpi and proboscis deep brown. Thorax rich brown, with long dark chaetae, pleurae pale ochreous; scutellum dusky brown, with dark border bristles. Abdomen black, with apical creamy median areas, venter pale creamy white. Legs deep brown, pale at the base, last two hind tarsi and most of the third creamy white; the last tarsals of the other legs show pale reflections. Wings with normal venation, but in certain lights subcostal, second, and fourth veins show brilliant violet reflections under the microscope. Length 4 mm.

"*Habitat.*—Onderstepoort, Transvaal.

"*Observations.*—Described from a single perfect female sent me by Dr. Theiler. It comes nearest *Uranotaenia apicotaeniata*, Theob., but can at once be told by the dark scaled head and the absence of pale apical bands on the first, second and third hind tarsals, and on the second tarsals of the fore and mid legs" (Theobald).

11. **U. fusca**, Theo., Mon. Cul. IV, p. 584 (1907).

*Ficalbia inornata*, Theo., Entomologist, XLI, p. 108 (1908).

*nec Uranotaenia fusca*, Leic., Stud. Inst. Med. Res., Fed. Malay States, III, iii, p. 227 (1908).

From the descriptions and from what is left of the types, there seems to be no character by which *F. inornata* can be distinguished from *U. fusca*. The types have apparently always been in very bad condition. A good series of this species has recently been received at the British Museum from Uganda (*Capt. A. D. Fraser*). The spot of blue scales on the pleurae is quite conspicuous, and so are the blue prothoracic lobes. The abdomen is uniformly deep blackish brown above, the venter uniformly whitish ochreous. The first fork-cell is longer than usual in this genus, but still distinctly shorter than the second. The male claws are quite normal: the inner one on the front feet is much thickened in both sexes, and in the female this is also the case on the mid tarsi.

Uganda; Sierra Leone; Transvaal.

12. **U. mashonaensis**, Theo., Mon. Cul. II, p. 259 (1901).

*Mimomyia mashonaensis*, Theo., Mon. Cul. III, p. 306 (1903).

*Uranotaenia bimaculata*, Theo., Mon. Cul. V, p. 522 (1910).

Theobald gave no reason for transferring this species to *Mimomyia*, to which genus it certainly does not belong, being an almost typical *Uranotaenia*. The first fork-cell is rather longer than in most *Uranotaenia*, this character being shared by *U. annulata*, ?*U.* candidipes, *U. fusca*, *U. ornata*, and *U. nigripes*. It is noticeable that these six species are also abnormal in having no flat blue scales on the mesonotum. In his new genus *Pseudoficalbia*, Theobald includes *U. fusca* (as *F. inornata*) and *U. nigripes* (which he has re-described from the Seychelles under two new specific names), and so *Pseudoficalbia* may be taken as applying to this section of *Uranotaenia*, though in the present writer's opinion the name

should not be retained even as a subgenus, as there seems no important structural character to distinguish these species from the rest.

Leicester (*l.c.* p. 226) describes a very similar, but probably distinct species as *U. bimaculata*; in this the black spots on the mesonotum are, he says, due to patches of black scales.

Uganda; Ashanti; Gold Coast; S. Nigeria; S. Rhodesia.

13. **U. ornata,** Theo., Mon. Cul. V, p. 521 (1910).

One ♀ from Mpumu, July, 1910 (*Capt. A. D. Fraser*) seems to belong to this species, but the thorax is rather yellower and to some extent approaches the following species.

Ashanti (♂); Uganda (♀).

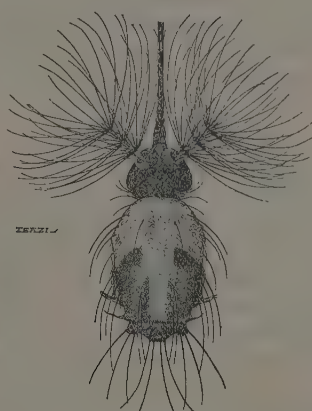

Fig. 7.—*Uranotaenia ornata*, Theo. Head and thorax of male.

14. **U. nigripes,** Theo., (*Ficalbia*), Ann. Mag. Nat. Hist. (7) XV, p. 199 (1905).
*Pseudoficalbia nigripes*, Theo., Trans. Linn. Soc. Lond. XV, 1, p. 89 (1912).
*Pseudoficalbia pandani*, Theo., *op. cit.* p. 90.
*Pseudoficalbia nepenthes*, Theo., *op. cit.* p. 92.

Sierra Leone; Seychelles Is.

It is doubtful if Leicester's *U. lutescens* (*l.c.* p. 222) from Malaya is distinct from *U. nigripes.*

Genus Ingramia, nom. nov.

*Mimomyia*, Theo., Mon. Cul. III, p. 304 (1903) (part).
*Dasymyia*, Leic., Stud. Inst. Med. Res., Fed. Malay States, III, iii, p. 102 (1908) (*nec Dasymyia*, Egger, 1858).

It is with great reluctance that a new generic name is introduced into a family which is already so overburdened with names, but in this case the procedure seems unavoidable. As already pointed out, the type species of Theobald's *Mimomyia* is generically distinct from the other members, and is in fact a *Ludlowia*. Leicester's *Dasymyia* is certainly applicable to the species erroneously placed in *Mimomyia*, as the only important difference between them and his *D. fusca* seems to be that in the latter the larger claw on the fore and mid legs of the male is toothed. Unfortunately, however, *Dasymyia* is preoccupied in

Diptera by a genus of Egger's, and thus it is necessary to coin a new name. It is with much pleasure that I name the genus after Dr. A. Ingram, who has done such excellent work in breeding many African CULICIDAE, and is the first to have reared any member of this genus from the larva. I take this opportunity of redefining the genotype, making it *Mimomyia malfeyti*, Newstead, the species which has been bred by Dr. Ingram.

Most of the characters will be gathered from the table, but the following may be added: Proboscis of male with the apical *half* much swollen, of female less swollen and then only at the tip; second segment of female antennae at least twice as long as the third; lateral vein-scales rather broad or very broad. In the African species the male claws are all simple.

*Ingramia* consists of small gnats resembling *Uranotaenia* in general appearance, and also structurally, in having the proboscis swollen towards the tip. The genus differs widely from *Mimomyia* in many respects, though it is curious to note that in some species of the latter genus the second segment of the female antennae is elongated.

*Table of the species.*

1. Anterior third of mesonotum pale ochreous, concolorous with the pleurae, the rest dark brown ... ... ... 1. *circumtestacea.*
   Mesonotum uniformly brown or dark brown ... ... ... ... 2.
2. Bristles of thorax long, in three distinct rows, the median one double; scales absent except for regular rows of minute ochreous scales between the rows of bristles ... ... ... 2. *malfeyti.*
   Bristles of thorax shorter, not arranged in distinct rows; scales uniformly distributed, though rather sparse, blackish ... ... 3.
3. Darker species; second joint of female antennae almost five times as long as third; integument of thorax all dark... ... 3. *nigra.*
   Paler species; second joint of female antennae hardly more than three times as long as third; three darker patches on thoracic integument... ... ... ... ... ... 4. *uniformis.*

1. **I. circumtestacea,** Theo. (*Mimomyia*), Third Rept. Wellc. Lab. p. 264 (1908).
Second joint of female antennae about five times as long as third.
Sudan.

2. **I. malfeyti,** Newstead (*Mimomyia*), Ann. Trop. Med. I, p. 29 (1907).
Easily distinguished by the peculiar arrangement of the vestiture of the thorax. Second joint of female antennae only twice as long as third. The male and female recorded from the Congo by Theobald (Mon. Cul. IV, p. 582) as *M. uniformis* are this species.
Congo; Gold Coast.

3. **I. nigra,** Theo., Mon. Cul. II, p. 237 (1901).
*Aedes niger*, Theo., *l.c.*
*Verrallina nigra*, Theo., Mon. Cul. III, p. 295 (1903).
*Mimomyia africana*, Newstead, Ann. Trop. Med. I, p. 28 (1907).
„ *fusca*, Theo., Novae Culicidae I, p. 32 (1911).

A distinct row of rather strong black bristles on the pteropleurae. The other three species have only weak, pale-coloured hairs in this position. *I. nigra* also

differs from the following in its blackish brown colour and the longer second joint of the female antennae. There is no doubt about the synonymy.

S. Nigeria; Congo; Uganda.

4. **I. uniformis**, Theo. (*Mimomyia*), First Rept. Wellc. Lab. p. 80 (1904).

The male type has disappeared from the Museum collection. Front of mesonotum with bluish sub-metallic sheen; brown patches on front of pleurae, iridescent grey when viewed from in front; a median and two posterior longitudinal dark patches on mesonotum, not very distinct.

Sudan; Lado Enclave; Nyasaland (Upper Shire, II, viii, 1911, *Prof. R. Newstead*).

### Genus Harpagomyia, Meij.

Tijd. v. Ent., LII, p. 165 (1909).

*Malaya*, Leic., Stud. Inst. Med. Research, Fed. Malay States, III, iii, p. 258 (1908) (nec *Malaia*, Heller 1891).

The name *Malaya* cannot stand, since *Malaia* has already been used for a genus of beetles.

The following is Leicester's diagnosis of the genus:

" This genus is founded on the characters of only one specimen, but it is of so remarkable an appearance as to fully warrant a new genus. Proboscis with a distinct joint, the apical portion much swollen and clad with long hairs. Head clothed with large racquet-shaped scales; mesonotum with narrow curved scales; scutellum with racquet-shaped scales. Metanotum with scales (?). Wings with fork-cells moderate length and clavate lateral scales. *Malaya genurostris*." Leicester remarks, " I cannot be sure whether the scales seen on the mesonotum [meaning metanotum] really belong to it or have been knocked on to it." Doubtless the latter supposition is the true one.

Mr. Carter first suggested to me that this genus was probably the same as *Harpagomyia*, and he is certainly correct. Leicester mentions the elongated clypeus in his description of the species.

Miss Ludlow (Psyche, XVIII, p. 132, 1911) raises this genus to subfamily rank, on account of the non-development of the biting parts of the proboscis, and (without giving any reason for so doing) associates with it *Hodgesia*, a blood-sucking genus.

Two African species have been described.

1. **H. trichorostris**, Theo., Mon. Cul. V, p. 548 (1910).

A median line of flat, bluish silvery scales on the mesonotum; proboscis almost all dark.

Ashanti.

2. **H. taeniarostris**, Theo., Novae Culicidae, I, p. 34 (1911).

No median line of flat scales on the thorax. Proboscis of the type specimen with the basal half pale, but in two other specimens it is almost all dark.

Uganda.

### Tribe **Sabethini.**

Metanotum bearing a tuft of long bristles near its posterior end. Anal segment of larva without median ventral brush.

This group is represented in Africa by a single endemic genus, *Eretmopodites*. Theobald, indeed, describes two African species of *Dendromyia*, but these have no bristles on the metanotum, and consequently cannot be included in the SABETHINI. They are here placed in *Stegomyia*.

It may be doubted whether this is really a natural group, as the presence of bristles on the metanotum does not seem to be quite constant.

Genus ERETMOPODITES, Theo. (*emend*).

*Eretmapodites*, Theo., Mon. Cul. I, p. 280 (1901).

Eyes very widely separated; prothoracic lobes rather small and widely separated; proboscis slender throughout, shorter than abdomen; clypeus bare; palpi of male thin, acuminate, nearly as long as proboscis; palpi of female short; fore and mid claws of female toothed; chaetae of metanotum rather short.

All the species have the head clothed with flat metallic silvery scales; the dorsum of the abdomen is black with a row of lateral silver patches, the venter uniformly golden yellow.

Fig. 8.—*Eretmopodites quinquevittatus*, Theo., male. Side view of insect, and head and thorax from above.

Leicester's *Chaetomyia* is probably related to *Eretmopodites*, but has the palpi more than half the length of the proboscis in the female. *Eretmopodites* is analogous to *Desvoidya*, *Chaetomyia* to *Leicesteria*.

*Table of the species.*

1. Prothoracic lobes covered with flat silvery scales ... ... ... 2.
   Prothoracic lobes entirely without flat silvery scales ... ... 6.
2. Hind tarsi of male simple ... ... ... ... ... ... 3.
   Hind tarsi of male feathered; thorax without distinct markings 4. *chrysogaster*.

| | | |
|---|---|---|
| 3. | Thorax without distinct markings ... ... ... | ... 3. *grahami.* |
| | Thorax distinctly striped ... ... ... ... ... | ... 4. |
| 4. | Thorax (scales) yellow, with distinct black stripes ... ... | ... 5. |
| | Thorax (scales) blackish, with narrow golden stripes | ...2. *inornatus.* |
| 5. | A median black longitudinal stripe on thorax ... | 1. *quinquevittatus.* |
| | No median black longitudinal stripe on thorax ... | ... (*condei*).* |
| 6. | Last two joints of hind tarsi white, simple in male ... | ... 5. *leucopus.* |
| | Last two joints of hind tarsi not white, tufted in male | 6. *oedipodius.* |

1. **E. quinquevittatus**, Theo., Mon. Cul. I, p. 280 (1901) (♀ only).
*E. austenii*, Theo., Mon. Cul. V, p. 572 (1910).

The original description of *E. quinquevittatus* was composite, applying to the male of one species and the female of another (*vide* Ann. Mag. Nat. Hist., July, 1911, pp. 67–73).

The majority of the British Museum specimens of *E. quinquevittatus* (and *E. condei*) show no sign of chaetae on the metanotum, and do not appear ever to have possessed them. In one or two individuals, however, they are present, and also in all the other members of the genus.

Sierra Leone ; Ashanti ; S. Nigeria.

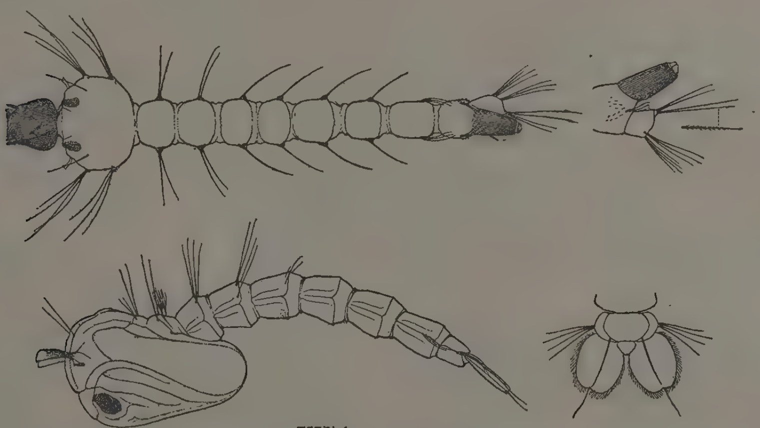


Fig. 9.—*Eretmopodites chrysogaster*, Graham. *Larva* from above, and side view of terminal segments ; *pupa* from side, and dorsal view of terminal segments. Uganda.

2. **E. inornatus**, Newstead, Ann. Trop. Med. I, p. 12 (1907).
*E. melanopous*, Graham, Entomologist, XLII, p. 158 (1909).
Sierra Leone ; Ashanti ; S. Nigeria ; Congo.

3. **E. grahami**, Edwards, Ann. Mag. Nat. Hist. (8) VIII, p. 71 (1911).
Ashanti.

4. **E. chrysogaster**, Graham, Entomologist, XLII, p. 157 (1909).
*E. quinquevittatus*, Theo., *l.c.* (♂ only).
Sierra Leone ; Ashanti ; Uganda ; German E. Africa (?).

* From Madagascar. Possibly only *E. quinquevittatus*.

The specimens from German East Africa were recorded by J. Vosseler (Deut. Ent. Zeitschr., 1907, p. 248) as *E. quinquevittatus*; they were taken at an altitude of 914 metres.

5. **E. leucopus**, Graham (*leucopous*), Entomologist, XLII, p. 88 (1909).
Ashanti; S. Nigeria (Bende, 1 ♀ taken in dispensary, 5 p.m. 14. v. 1911, *Dr. Macdonald*).

6. **E. oedipodius**, Graham (*oidipodeios*), Entomologist, XLII, p. 86 (1909).
Ashanti; Gold Coast (Bibianaha, *Dr. H. G. F. Spurrell*); Uganda (Damba Island, L. Victoria Nyanza, *Dr. G. D. H. Carpenter*).

## Sub-family 2. CHAOBORINAE.

Proboscis not longer than the head; palpi curled downwards and inwards; antennae of male plumose, of female verticillate; thorax projecting somewhat over the head; claws equal and simple in both sexes (except *Pelorempis*); the whole insect hairy, the wings densely so; scales absent (except on the wing-fringe and, in *Ramcia*, on the veins of the wings).

### Genus Chaoborus, Lichtenstein.

Arch. Zool. (Wiedemann's) I, p. 174 (1800).

*Corethra*, Mg., Illiger's Mag. II, p. 260 (1803) (part), *et auct.*
*Sayomyia*, Coq., Can. Ent. XXXV, p. 402 (1903).

Although Lichtenstein's *Chaoborus antisepticus* is probably not determinable specifically, as he only described the larva, yet his description and figure are quite recognisable as applying to some species of *Corethra* (*Sayomyia*), and hence his name must be used, as it was published three years before Meigen's.

Only two African species belonging to this sub-family have been described, each from a single female, both being true *Chaoborus*.

1. **C. ceratopogones**, Theo., Mon. Cul. III, p. 338 (1903).
A small species, the femora and tibiae with numerous small dark rings. Wings with three dark blotches on the costa. A very pretty and distinct species, much resembling *C. queenslandensis*, Theo.; the latter differs in venation and in having only two dark spots on the costa. The European *C. pallidus*, F., is somewhat similar, but is much larger and has only a median dark mark on the wings extending from the costa over the cross-veins.
Gambia.

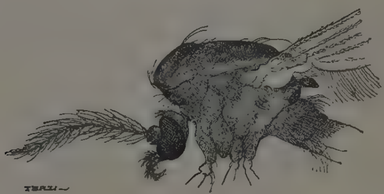

Fig. 10.—*Chaoborus pallidipes*, Theo. Side view of head and thorax.

2. **C. pallidipes**, Theo., Ann. Mag. Nat. Hist. (8) VII, p. 399 (1911).
Legs all pale; wings unspotted; thorax dark above.
Uganda.

## Sub-family 3. DIXINAE.

Whole insect, notably the antennae (in both sexes) and the wings, almost bare; head and thorax as in CHAOBORINAE; neuration of the Culicid type, but differing in some details, principally in the course of the second vein; in the male the claws of the fore and mid legs are larger than those on the hind legs, and bear several long, fine teeth on the under side; in the female the claws are all equal and simple.

That *Dixa* is related to the CULICIDAE is now well recognised: Williston favours its inclusion in the family, making three sub-families of CULICIDAE—as here; Dyar would group *Dixa* with *Chaoborus* and its allies into a separate family. The inclusion of *Dixa* with the CULICIDAE is supported by (1) the structure and habits of the larvae and pupae; these, according to Knab, are subject to much variation in *Dixa*, but are essentially similar to what is found in the CHAOBORINAE; (2) the neuration of the adults, which is of a form found only in *Dixa* and the CULICIDAE; (3) the structure of the adult antennae, with one globular basal joint, common to CULICIDAE, *Dixa*, and CHIRONOMIDAE, but never seen in the Tipulid series; (4) the occurrence of more or less intermediate forms between the three sub-families, such as *Ramcia* and *Mochlonyx*; (5) the differentiation in the claws—in the Tipulid series, so far as I have seen, the claws are all alike.

### Genus DIXA, Mg.

Syst. Beschr. I, p. 216 (1818).

Two specimens of *Dixa* from Morocco are in the British Museum collection, collected by Major P. Fowler, R.A.M.C., in 1909. These I have provisionally determined as follows:

1. **D. maculata**, Mg., Syst. Beschr. I, p. 219 (1818).
Cross-veins much darkened, faint clouds on the wings; thorax blackish; legs yellowish; femora and tibiae blackish at tip, tip of hind tibiae somewhat swollen.

2. **D. aestivalis**, Mg., Syst. Beschr. I, p. 218 (1818).
Wings clear; thorax reddish; legs all yellowish brown.

*List of new names proposed in this paper.*

### *List of proposed emendations.*

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# INDEX.

[Tabulated African genera and species in heavy type ; synonyms in italics.]

# NOTES ON THE OCCURRENCE AND HABITS OF GLOSSINA FUSCIPES IN UGANDA.

By Dr. Robert E. McConnell.

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When I assumed duty in the Nile Province of the Uganda Protectorate, it was known to me that Dr. Shircore had taken a tsetse-fly near Nimule, which he considered to be nearly allied to, but distinct from, *G. palpalis*. I had been asked to take an early opportunity of examining the haunt of these insects and capturing further specimens. On several occasions I therefore repaired to the site of Dr. Shircore's find, and along some two miles of the bank succeeded in taking a large number of *Glossina*. These did not appear to differ in any noticeable degree from those one had seen on Lake Victoria, or on the smaller rivers of this Province, and as Dr. Shircore had reported that he had frequently seen the fly in question with the larger *palpalis*, especially near Nimule, I came to the conclusion that I had been very unfortunate in not taking a single specimen.

Some time later on returning from an extensive "safari," I read Prof. Newstead's article (Bull. Ent. Res. II, pt. i) on the classification of *Glossina* by the hypopygial structures, and immediately examined flies representing the various stream-systems of the Province. The specimens were treated in the manner recommended by Newstead (*loc. cit.*) and mounted in Canada balsam. In each case the structure of the hypopygium was found to correspond (with minor variations to which reference will be made later) to Newstead's new species *G. fuscipes*. On 6th August I telegraphed to the Principal Medical Officer to this effect. Further flies taken in the neighbourhood of Nimule were subjected to examination and supplied confirmation as to the uniformity of the type prevailing there.

I went to Wadelai, which is situated in the midst of a sleeping sickness area and where Dr. Shircore believed he had seen the new fly together with *palpalis*. All, however, agreed, upon examination, with those taken elsewhere in the Province. On 5th September I telegraphed to the Principal Medical Officer to this effect, and submitted that *G. fuscipes* was presumably a sleeping sickness carrier.

On the 12th September I received two male specimens of the *palpalis* group from Lake Edward and on the 28th September others from Lake Victoria. These all conformed to the description of *fuscipes*, a report to this effect being made.

It then became evident that all tsetse hitherto designated as *palpalis* East of the watershed between the great lakes and Nile system on the one hand, and the Congo River system on the other, would, with little doubt, be found to be *G. fuscipes*. Further than this one could not go as no specimens of the true *palpalis* from the Guinea Coast were at hand for purpose of comparison.

Of numerous specimens examined here only one agreed with the small size (7·5 mm.) of the type specimen. The majority were between 8 and 9 mm. in the case of males (average of eight specimens, 8·5 mm.) and between 9 and 10 mm

in the case of females (average of five specimens, 9·5 mm.). In the dried condition no doubt these measurements would be somewhat smaller.

In the female the hind femora and tibiae are lighter than in the male, so that the contrast with the dark tarsi is more marked. So usual is this distinction that one may, in a large proportion of cases, distinguish the sexes by examining the hind leg alone. The last joint of the front and middle tarsi presents a brown colouring near the insertion of the claws, but the rest of it retains the colour of the other tarsi, *i.e.*, yellowish ; under the dark brown bristle-like hairs on the penultimate joint of the same members there may or may not be some browning of the distal portion. In both these cases the middle tarsi tend to be darker than the front tarsi.

Turning to the male hypopygium I have found the distal appendage to the superior clasper to be distinctly claw-like but not to such an extent as depicted by Newstead. Unless the cover-glass is pressed down tightly these claws are not seen to the best advantage. I have found that the extent of the claw curve was best estimated by examining the unmounted specimen and manipulating it until the lateral surface of the claw was presented to the microscope.

The angle between the distal third and the proximal two-thirds of the outer surface of the superior claspers I have not found to be as marked as in the description of the type. But as Newstead only examined one specimen this effect may have been exaggerated through some accident in the mounting. In fact, in a few of my mountings one clasper assumed the exaggerated position. The inferior clasper in the mounted specimen has the internal distal portion prolonged into a sickle-shaped process with the tip pointing in the direction of the outer lateral margin. In the unmounted state, however, after following such a course for almost one-third of its length the terminal portion then runs almost vertically from the plane of the hypopygium. When the latter is viewed from

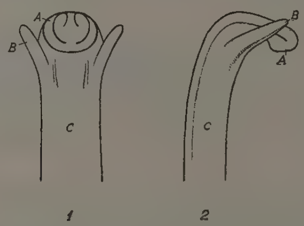


Diagram of vesica of *Glossina palpalis*.
(1) anterior view ; (2) lateral view ; (A) cephalic process ; (B) lateral processes ; (C) trunk.

the side these two mast-like processes are well seen. The vesica forms a prominent structure. On several occasions I observed its movements in the living fly. The head-like terminal portion nodded energetically, and at the same time the lateral arm-like processes approached each other while the whole structure moved slightly antero-posteriorly. Accompanying this action the inferior claspers approached each other moderately. Sometimes a drop of watery, slightly turbid fluid gathered on the apex of its cephalic process.

The most favourable environment for the fly in this Province consists of the conjunction of a tree- or scrub-shade, water, and a rocky clean bank. They are often very numerous on rocky promontories, the vegetation on which offers the very modest shade lent by creepers, tufts of grass, and scattered, very low scrub. They are also very common on bare rocks, but these have always been so situated that access to typical tree-shade was available, and doubtless the flies retired there. They seem quite as numerous near rushing rapids as near the more peaceful waters. The streams of the Province have a fringe of small forest or scrub on either side, for the most part continuous, but often with patchy grassy intervals. It is only when very rarely a forest or banana plantation comes to the water's edge that the tsetse range more than a few yards from it. They extended throughout one such banana grove which I chanced to examine.

In a semi-forest extending to the river bank and having numerous open grassy patches they were found to range as far as I penetrated, which was about half-a-mile. Large numbers of hippopotami and lesser numbers of other game traversed this area. In another case, somewhat widely scattered clumps of bush were found to harbour the fly for a distance of one to two hundred yards from the river. These had no doubt in the first place attached themselves to hippopotami and then abandoned them for the shade of the trees, and being unwilling to face the comparatively long flight in the open to the next clump or the river bank had become at least temporarily isolated.

Flies have been taken in a village a mile and a half from the nearest stream, the intervening country being open, but undoubtedly in such cases they had attached themselves to water-carriers or travellers. Nevertheless I do not think these excursions are altogether comparable to those of *palpalis* on the Guinea Coast, where they are described as infesting whole villages, roads, and large sections of forest. In the Gold Coast I found the high forest-clad hills near Berekusa (some 20 miles north of Accra) to be haunted by *palpalis* over a considerable area. Many oil palms grew in this region.

Where the irregularity of the rocks offers shady under-surfaces, these seemed to me to be the favourite resting places. Less frequently the under surfaces of leaves or small branches were resorted to.

While rowing during a moderate rainfall at a distance of some 50 to 75 feet from the Nile bank large numbers of fly kept boarding us. Some, instead of seeking the shelter of the awning, hovered around sailors seated in the bow, being entirely exposed to the weather's inclemency. This observation should, I think, tend to moderate the generally accepted view of the rigorously inimical effect of rain on their activities.

During the dry season, when everything here is parched, I examined a number of small stream-beds near watersheds (February). These were either dry or consisted of a series of pools. In most cases no flies were taken. When these water-courses were revisited in the wet season (June) tsetse were invariably found right up to their immediate swampy sources. It seems to me that this would point to a migration within limits. In the wet season too they have been observed for considerable distances up sandy waterless stream-beds which could only contain running water for a few hours after heavy rain.

On the Nile itself there seems to be no marked diminution of their numbers in the dry season. It would appear that a dense belt of reeds or papyrus in the course of a stream—even if only about one hundred yards wide—would prove a complete obstacle to their upward advance, unless a game or human track bridged the interval. Advantage might be taken of this by completely clearing the banks of the higher reaches of streams in the dry weather, then putting in a small dam at the boundary of this fly-free area, backing it up with soil and putting in papyrus. In a region like this Province, where almost every source of supply of household water harbours these flies, it would be of interest to undertake an experiment of this nature.

I had become impressed with the apparent marked numerical superiority of the males along the large rivers and of the females on the smaller streams. In roughly testing this, 40 flies taken on the Nile in October were found to comprise 35 males and 5 females; and 77 taken in July comprised 67 males and 10 females. Of 56 flies captured in September near the mouths of small tributaries of the Nile between Nimule and Wadelai, 24 were males and 32 females. I feel sure that if in the latter enumeration the flies had been taken from some 20 miles up-stream the females would have been shown to outnumber the males to a much greater extent. These figures are too small to attach any importance to them, but they seem to be borne out by the results obtained by others. Although he did not contrast the sites of capture in this light, Kleine (quoted S.S. Bulletin No. 11, 1909) found that of two batches of flies from islands in Lake Victoria, 23 per cent. and 13 per cent. respectively were females while of a large number taken on the banks of the Mori River 68 per cent. were females. Of a large capture on an uninhabited island in Tanganyika, Kinghorn and Montgomery found only 9 per cent. to be females, while Degen in Lake Victoria of a still larger number found the females to form 22·19 per cent. Bagshawe took 1,176 males and 1,662 females in Lakes George and Edward and tributary streams: it would have been interesting if he had kept the river returns separate.

In this Province the population is small and the villages widely scattered. Game over wide areas has succumbed to the ruthless methods of hunting adopted by the inhabitants, therefore on many smaller streams the opportunities of feeding on blood of the larger mammals would be rare. On the Nile itself hippopotami and crocodiles exist in large numbers but only rarely in the tributaries.

I have frequently taken pet monkeys to fly-infested places but owing to their alertness have never observed one to be bitten. Indeed they try to capture the insects if they alight, and, if successful, greedily eat them.

I have been unfortunate in not finding any pupae or pupa-cases in the Province. It would seem that the marked contrast between the sites in which the pupae are found on the Guinea Coast and in Uganda might have given a hint of a specific difference in the flies.

At one time I made up my mind that these flies on settling did not move about on the host, but latterly I have observed two instances which proved that that opinion was inaccurate. These flies moved about two inches; in one case there was no obvious cause for the movement, while in the other a passing twig disturbed it.

The fact that *fuscipes* and not *palpalis* would seem to be the intermediary host for *Trypanosoma gambiense* in Uganda, while of interest, is of no importance in itself; but it may prove a factor in solving the question of the difference in virulence in trypanosomiasis as seen on the West Coast and in Uganda, and also the lessened reaction to treatment of the Uganda type. For if *G. fuscipes* should prove a more favourable intermediate host the organism would very probably have its virulence enhanced in the passage. A recent report from Togoland gives the percentage of apparent cures as 67 per cent.* I do not know the percentage for Uganda but it would appear to be almost negligible.

In view of the noticeable difference in the habits of the Central Africa *fuscipes* and the West African *palpalis*, the strongly contrasted sites chosen for the deposition of larvae and the difference, though less in degree, in the external characters, it seems a matter of wonder that the specific, or possibly subspecific, distinction should not have been established much earlier.

Nimule, Nile Province, 7th November, 1911.

[So far as the present evidence goes, Dr. McConnell's suggestion that all Uganda specimens of *G. palpalis* are probably referable to the form *fuscipes*, Newst., seems likely to be justified. He has sent mounted examples of his dissections to the Entomological Research Committee, and there can be no doubt as to the correctness of his determinations. Moreover, Dr. J. J. Simpson, while in England, made preparations of the male genitalia of other Uganda specimens, all of which are clearly referable to the same form. On the other hand, it must be pointed out that the essential external characters given by Prof. Newstead for *G. fuscipes* and based on his single (apparently dwarfed) specimen, do not appear to be normal; and in spite of careful examination by Mr. E. E. Austen, Dr. Simpson and the writer, it has not been possible to find any constant, reliable external character by which *G. fuscipes* can be distinguished from typical *G. palpalis*. Mr. Austen has recently dissected out the genitalia of some dark forms of *palpalis* from the Congo, and these agree essentially with those of the Uganda *fuscipes*. In the circumstances it seems advisable to treat *G. fuscipes* merely as a local form of the Western *G. palpalis*. It is very improbable that the greater virulence of sleeping sickness in Uganda is really connected with the small sub-specific difference in the *Glossina* which carries it. The more probable explanation is that it is due to the fact that the disease has been only recently introduced into Uganda; whereas there is now evidence that sleeping sickness has long been endemic in parts of West Africa, so that we should expect the production of a fairly high degree of immunity in the natives by the simple process of selection.—Ed.]

* [This estimate has clearly no real value, for Zupitza records (cf. Sl. Sick. Bull. 1909, p. 400) that in the treatment camps in Togo patients who have remained well for six months after treatment are regarded as cured; a method which is condemned by Dr. Bagshawe as "unjustifiable and possibly mischievous."—Ed.]

# EXPERIMENTS AND OBSERVATIONS UPON GLOSSINA PALPALIS.

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In Northern Nigeria the dry season begins in October, and ends in March. During this period practically no rain falls, and the highest temperatures of the year are recorded during the day, whilst the lowest annual temperatures occur during the night at this season. A short tornado season occurs at the beginning and end of the dry weather. In the case of Zungeru, where my experiments were carried out, the following is the meteorological return for the year 1910:—

ZUNGERU. 1910.

| Month. | Temperature (Fahrenheit). | | | | Rainfall. | | Wind. |
|---|---|---|---|---|---|---|---|
| | Shade maximum. | Shade minimum. | Range. | Mean. | Amount in inches. | Degree of humidity. | |
| January ... ... | 102 | 57 | 45 | 78 | — | 34 | N.E. |
| February ... ... | 102 | 62 | 40 | 83·7 | — | 33 | N.E. |
| March ... ... | 107 | 65 | 42 | 86 | ·83 | 36 | N.E. |
| April ... ... ... | 103 | 70 | 33 | 87·7 | 1·15 | 61 | S.W. |
| May ... ... ... | 101 | 69 | 32 | 83·5 | 6·69 | 73 | S.W. |
| June ... ... ... | 95 | 66 | 29 | 80·9 | 5·54 | 79 | S.W. |
| July ... ... ... | 91 | 67 | 24 | 78·7 | 7·09 | 82 | S.W. |
| August ... ... | 90 | 68 | 22 | 78 | 19·27 | 86 | S.W. |
| September ... ... | 92 | 67 | 25 | 78 | 10·82 | 84 | S.W. |
| October ... ... | 96 | 61 | 35 | 81 | 2·05 | 77 | Various. |
| November ... ... | 98 | 57 | 41 | 79 | — | 42 | N.E. |
| December ... ... | 99 | 60 | 39 | 79·7 | — | 37 | N.E. |
| Year ... ... | 107 | 57 | 50 | 81·2 | 53·44 | 60 | N.E. & S.W. |

It will be observed that both the maximum (107° F. or 41·6° C.) and the minimum (57° F. or 13·8° C.) shade temperatures occurred during the dry season, and that whereas the average degree of humidity was 80·8 for the five months (May, June, July, August and September) of the rainy season, it fell to 36·5 for the four months (November, December, January and February) during which no rain fell.

As the dry season advances the tsetse-flies (*G. palpalis*), which in the rainy season are more widely distributed over the country, gradually shrink back towards the rivers, until in January they are only to be found in a few patches of bush along the river banks. The causes that help to bring about this change in the distribution, which first suggest themselves, are, the greater degree of coldness of the nights, the unclouded hot days, and the diminished humidity of the atmosphere due to the dry harmattan wind which, at this season, blows down from the north-east. The object of the experiments described below was to determine the relative importance of these several factors.

A note should perhaps be included here on the manner of death of the flies used in the experiments. When an exposure was nearing a fatal termination the flies became less active, and would presently settle on a twig, or on the floor of the jars in which they were contained, in a lethargic condition, being with difficulty persuaded to move, even when touched with the end of a probe. A little later they would fall over on to their backs with their legs pointing up into the air, and their probosces projecting forwards. In this state they might remain for a considerable time. At first, when disturbed, they would be able to struggle to their feet, only to fall over on to their backs again in a few moments. Later they were only able to respond by movements, more or less free, of the legs and proboscis. In this condition, which in the notes of my experiments I have described by the expression "as if dead," they remained until death took place, the movements gradually becoming less perceptible. In exposures to an increased temperature the flies sometimes spread out their wings convulsively just before death. After death the proboscis was generally depressed.

## The Effect of a Lowering of the Temperature.

In order to determine the effect of lowering the temperature on *G. palpalis* a simple cold chamber was constructed by filling a large glass jar with ice and salt, or ice and water, in which a smaller glass jar fitted with a thermometer was completely immersed. Into the smaller jar the fly was introduced together with some leafy twigs on which it might alight. In such a chamber it was possible to watch simultaneously the fluctuations of the temperature and the behaviour of the imprisoned fly.

As the minimum temperature recorded at Zungeru in 1910 was 57° F. (13·8° C.), a few experiments were at first carried out at temperatures of this order. It was found, however, that with the exception that the flies became somewhat sluggish, as if numbed, these temperatures had little effect. In one experiment two male flies were exposed to 60–62° F. (15·5°–16·6° C.) for two hours. On removal to the external air at 90° F. (32·2° C.) they appeared to be numbed and were with difficulty persuaded to move. Five minutes later, however, they were quite lively and actively flying about.

The effect of lower temperatures was then examined. The following are the notes of one of the experiments :—

No. 1.—One male and one female *G. palpalis*. Temperature of the external air—24° C. (75·2° F.).

| | | |
|---|---|---|
| 8.5 p.m. | T. 12° C. | Flies introduced into the cold chamber. |
| 8.8 | T. 11 | Male fell to the ground "as if dead." Female still active. |
| 8.10 | T. 10 | Female resting on a twig. |
| 8.11 | T. 8 | Female fell to the ground "as if dead." |

Both flies were then removed to a box at the temperature of the external air. The female recovered activity immediately, but the male only after a little time, and was unable to fly until 8.20 p.m.—9 minutes later.

An experiment was then made with a recently captured female *G. palpalis* :—

No. 2.—Female *G. palpalis*. Temperature of the external air—
33° C. (91·4° F.).

| | | | |
|---|---|---|---|
| 12.5 p.m. | T. 10° C. | Fly introduced. She at once settled on the floor of the chamber. | |
| 12.15 | T. 10 | Fly has not moved at all. | |
| 12.35 | T. 10 | Do. | |
| 12.40 | T. 10 | Position unchanged. | Stroking wings with hind legs. |
| 12.45 | T. 9·5 | Do. | |
| 12.55 | T. 10 | Do. | |
| 1.5 | T. 10 | Do. | Stroking wings. |
| 1.15 | T. 10 | Do. | |
| 1.20 | T. 7 | Do. | |
| 1.25 | T. 7 | Do. | |

The fly was then removed from the cold chamber, and rapidly recovered her activity.

The female *G. palpalis* is therefore able to withstand exposure for an hour and twenty minutes to a temperature ranging from 10°–7° C. (50°–44·5° F.) without harm. This is a degree of cold to which she would never be exposed naturally at Zungeru, where the minimum temperature recorded in 1910 was 13·8° C.

In the case of the male used in the following experiment, twenty minutes exposure to a temperature falling from 16° to 7° C. (60·8° to 44·5° F.) resulted in reducing the fly to an inert condition, from which, however, he recovered rapidly on being removed from the cold chamber.

No. 3.—Male *G. palpalis*.

| | | | |
|---|---|---|---|
| 11.40 a.m. | T. 16° C. | Fly introduced. Settled on a twig. | |
| 11.45 | T. 10 | Fly has not moved. | |
| 11.50 | T. 9 | Do. | |
| 11.52 | T. 8 | Do. | Proboscis depressed. |
| 11.55 | T. 7·6 | Do. | |
| 12.0 | T. 7 | Fly fell off the twig "as if dead." | |

At once removed to the external air. Recovered activity rapidly.

Temperatures sufficiently low to render the flies inert are not therefore necessarily fatal. In one case a fly was allowed to remain in this condition for five minutes at a temperature ranging from 8°–5·5° C. (46·4°–42° F.), and recovered completely within two minutes after being removed to the temperature of the external air which was at the time 27° C.

That *G. palpalis* can resist relatively low temperatures the following experiment proves. It also indicates the probable limit of low temperature, beyond which recovery does not take place ; as the fly, after having been exposed to a temperature at one time as low as 2·5° C. (36·5° F.), only recovered partially on being removed from the cold chamber, and subsequently died within twelve hours.

| | | No. 4.—Male *G. palpalis.* |
|---|---|---|
| 8.50 p.m | T. 10° C. | Fly introduced into the cold chamber. He buzzed about for a moment, alighted on the side of the jar, and fell over immediately "as if dead." |
| 8.52 | T. 8 | — |
| 8.55 | T. 4 | — |
| 9.0 | T. 3 | — |
| 9.5 | T. 2·5 | — |
| 9.10 | T. 3 | — |
| 9.15 | T. 3 | — |
| 9.20 | T. 3·5 | — |
| 9.25 | T. 4 | Fly removed from the cold chamber having been in an inert condition for 35 minutes. |
| | | Temperature of the external air—26° C. |
| 9.28 | — | Slight movements of the legs. |
| 9.31 | — | Abortive attempts at flight. |
| 9.40 | — | Still very unsteady on his feet. |
| 10.0 | — | Able to fly, but still very uncertain on his feet. |

This fly never recovered completely, but died at about 9.30 a.m. on the following morning.

The immediate effect of a lowering of the temperature on *G. palpalis* is to cause a reduction in activity. Should the temperature fall to a point varying from 10° C. to 6·5° C. the fly becomes inert, and falls to the ground as if dead. Partial recovery was found to occur even after half an hour's exposure in this condition to a temperature ranging from 2·5° C. to 4° C. Recovery from less severe exposures was complete, and accompanied by violent buzzing.

In Zungeru, as will be seen on reference to the meteorological return for 1910, given above, such low temperatures as those used in these experiments do not occur. The same applies in the case of the other stations in Northern Nigeria in which *G. palpalis* is found. Practically never does the temperature fall as low as 10° C., a degree of cold which *G. palpalis* has been shown experimentally to withstand for a considerable length of time. No doubt, however, the cold of the harmattan does play a part in the reduction of the number of tsetse-flies during the dry season, by numbing them so that they cannot feed, and by rendering them a more ready prey to their natural enemies.

## The Effect of Raising the Temperature.

In considering the effect of a rise in temperature upon *G. palpalis* account must be taken of the highest temperatures to which the fly may naturally be exposed. On reference to the meteorological return for Zungeru, given above, it will be seen that these occur during the months covering the latter part of the dry season and the commencement of the rainy season, and that the maximum temperature recorded in 1910 was 107° F. (or 41·6 C.). High temperatures, therefore, occur both when the degree of humidity of the atmosphere is low, and when it is beginning to rise owing to the onset of the rains ; and account of this had to be taken in planning experiments. It was also recognised at the outset

that a distinction must be made between shade temperatures, and those attained by direct exposure to sunshine. In the following experiments tsetse-flies were exposed to the various temperatures in glass jars fitted with a thermometer. Twigs on which the flies might settle were always present. It may be stated at once that the flies appeared to be much more susceptible to a raising of the temperature than they were found to be to a lowering. In the experiment described above as No. 4, the fly withstood for some time a lowering of the temperature of 23·5° C. (*viz.*, from 26° C. to 2·5° C.), whereas in experiment No. 8, a raising of the temperature only 10° C. (*viz.*, from 34° C., the temperature of the external air at the time of the experiment, to 43°–44° C.) was more than could be endured.

## In direct sunlight.

(a.) *In the absence of water.*

In these experiments tsetse-flies were exposed in glass jars to the direct rays of the sun. Small twigs were included in the jars, but no water. The following experiment will indicate the nature of the effects observed.

No. 5.—Male *G. palpalis*. Degree of humidity of the atmosphere—25.

| | | |
|---|---|---|
| 2.4 p.m. | T. 34° C. | Fly exposed to direct sunlight. |
| 2.6 | T. 38 | Fly active. |
| 2.7 | T. 40 | Do. |
| 2.8 | T. 41 | Fly fell to the floor and rolled over "as if dead." |
| 2.13 | — | After five minutes in this condition and at this temperature he was removed to a box at the temperature of the external air. |

No recovery took place.

Direct sunlight, in the absence of moisture, is therefore rapidly fatal to *G. palpalis*; in this case five minutes exposure at 41° C. having proved fatal.

(b.) *In the presence of water.*

The present experiments only differed from those described above in the fact that water was present in the jars. The following are the notes of one experiment:—

No. 6. Male *G. palpalis*. Water and twigs in the jar. The temperature of the external air was 31·5° C. (88·7° F.).

| | | |
|---|---|---|
| 12.29 p.m. | T. 40° C. | Fly introduced. Active. |
| 12.32 | T. 41 | Fly active. |
| 12.35 | T. 41 | Do. |
| 12.37 | T. 41 | Fly active; looking for shade. |
| 12.40 | T. 41 | Do. do. |
| 12.43 | T. 41 | Fly fell over on to his side, but got up again. Less active. |
| 12.44 | T. 41 | Less active. |
| 12.45 | T. 42 | Fly fell over again, but got up with difficulty. |
| 12.48 | T. 41 | Fly crawling about looking for shade, and constantly falling over and getting up again with increasing difficulty. |

| | | |
|---|---|---|
| 12.54p.m. | T. 41 | Fly fell over and failed to get up again. Slight movements. |
| 12.59 | T. 41 | After five minutes in this condition the fly was removed to a box at the temperature of the external air. He did not, however, show any signs of life. |

In the presence of moisture therefore it would appear that *G. palpalis* is able to withstand exposure to sunlight for longer than in its absence. In this case 25 minutes at 41° C. (105·8° F.) elapsing before complete immobility was induced, as compared with four minutes in the previous experiment (no. 5). A further exposure of five minutes was however fatal.

It was observed that the first effect on the flies of exposure to sunlight was an increased activity. After a few minutes, however, they began to seek shade, and became less active, until finally they were reduced to an inert condition from which recovery, if it took place at all, was slow and often incomplete.

## When shaded from direct sunlight.

The jars containing the flies in these experiments were protected from the direct rays of the sun by a covering of thick brown paper. In some experiments water was present in the jars, in others it was absent.

### (a.) *In the absence of water.*

The following experiment will indicate the nature of the effects of a raising of the temperature under these conditions :—

No. 7.—Male *G. palpalis* confined in a glass jar, wrapped in thick brown paper so as to shade every part, together with a few twigs, but no water. Degree of humidity of the atmosphere—25.

| | | |
|---|---|---|
| 2.24 p.m. | T. 35° C. | Fly introduced. Active. |
| 2.27 | T. 38 | Fly active. |
| 2.32 | T. 39 | Do. |
| 2.35 | T. 40 | Do. |
| 2.38 | T. 41 | Fly resting on the floor. |
| 2.43 | T. 41 | Fly active. |
| 2.50 | T. 41·5 | Do. |
| 2.55 | T. 41 | Do. |
| 3.0 | T. 40 | Do. |
| 3.5 | T. 40·5 | Fly resting on the floor. |
| 3.10 | T. 41 | Fly fell over "as if dead." On shaking the jar he got up on his legs again and moved about. |
| 3.15 | T. 41 | Fly resting on the floor. |
| 3.20 | T. 41 | Fly fell over "as if dead," and failed to get up again. There were, however, slight movements of the legs. |
| 3.25 | T. 41 | Slight movements still. |
| 3.30 | T. 41 | Do. do. |
| 3.35 | T. 40 | No signs of life. |

Fly removed to a box at the temperature of the external air (35° C.), he was, however, dead.

In this experiment a fatal result was only produced after an hour's exposure to a temperature of 40°–41° C. This result should be contrasted with that produced by direct sunlight. In other experiments at this temperature, when the flies were removed from the jars immediately they fell "as if dead," partial recovery took place, but in no case was it complete. It was noticed in one case that the right foreleg remained useless and bent up under the thorax.

(b.) *In the presence of water.*

In the presence of water the effects of a temperature of 40° C. are perhaps a little less severely felt than in its absence, as in one experiment of this nature a male *G. palpalis* was not reduced to a condition of complete immobility by one hour's exposure. On removal to a box at the temperature of the external air he made but a slight recovery, and died within three hours. In another experiment carried out under the same conditions 40 minutes' exposure to T. 40°–41° C. proved fatal, so that the difference if it exists is a small one.

(c.) *Higher temperatures.*

Temperatures higher than those employed in the foregoing experiments (40°–41° C.) are, however, rapidly fatal. The following experiment may be compared with experiment No. 7, which was carried out under similar conditions. In the latter all movements of the fly ceased, and death ensued after 60 minutes' exposure to T. 40°–41° C. (104°–105·8° F.), in the former death resulted after only 22 minutes at T. 43°–44° C. (109·4°–111·2° F.).

No. 8.—Male *G. palpalis* in glass jar shaded from direct sunlight. No water present in the jar, but only a few twigs. Degree of humidity of the atmosphere—27.

| | | |
|---|---|---|
| 2.16 p.m. | T. 44° C. | Fly introduced. Very active. |
| 2.17 | — | Fly taking short flights. |
| 2.18 | T. 43 | Fly on his back; got up again. |
| 2.20 | T. 43 | Fly on the floor. |
| 2.22 | T. 43·2 | Fly on his back; struggled up again. |
| 2.24 | T. 43·5 | Fly on his back, unable to rise. |
| 2.26 | T. 43·5 | Slight movements. |
| 2.28 | T. 43·5 | Do. |
| 2.30 | T. 43·5 | Movements scarcely perceptible. |
| 2.32 | T. 44 | Do. do. |
| 2.34 | T. 43·8 | Do. do. |
| 2.36 | T. 43·8 | Slight movements on shaking the jar. |
| 2.38 | T. 43·8 | No movements observed. |

Fly removed to a box at the temperature of the external air (34° C). Died.

## Conclusions.

1. *Glossina palpalis* is able to withstand a lowering of the temperature to 10°–7° C.
2. Direct sunlight is rapidly fatal to *G. palpalis*.

3. When shaded, exposure for one hour to a temperature of 40°–41° C. is fatal to the male *G. palpalis*. Higher temperatures are more rapidly fatal.
4. The presence of water enables *G. palpalis* to withstand for a longer period the action of direct sunlight, and perhaps of a shade temperature of 40°–41° C.

It is probable, therefore, that the diminution in the number of tsetse-flies during the dry season, and their limitation to the bush along the river banks, is due not so much to the low temperatures registered at nights during this season, nor to the high temperatures occurring during the days, as to the dryness of the atmosphere and the burnt up condition of the country.

## Notes on the Bionomics of Glossina Palpalis.

The following more or less disconnected observations and experiments were made at Zungeru in Northern Nigeria during December, 1911, and January, 1912. These months cover the height of the dry season when the tsetse-flies (*G. palpalis*) are restricted to a few shady patches of bush along the river banks, probably owing (as indicated by the foregoing experiments) to their intolerance of the dryness of the atmosphere and the burnt up condition of the country. Of the flies brought to me the proportion of males to females was as three to one, but whether this was due to the females being actually less numerous than the males, or to the fact that they were shyer feeders or more cunning at avoiding capture, it is impossible to say. The fact that in some of the temperature experiments the females seemed to be more sensitive than the males to a raising of the temperature may have had something to do with it, as they may have been less eager to fly out into the sunshine to feed and may thus have escaped capture. The converse, namely that the female is apparently less affected by cold, may account for the fact that on one occasion only, on a singularly cool and sunless day, the proportion was reversed, namely three females being taken for every male. The flies were also found to be susceptible to wind, and on the days when the harmattan wind was blowing strongly few or no flies were caught.

### Feeding and Digestion.

In considering the processes of feeding and digestion of *G. palpalis* it was found to be essential that the flies should be naturally fed. At first, attempts were made to feed them on such things as the liver of a fowl just killed, or even on freshly shed human blood, but although the flies sometimes succeeded in sucking nourishment from them, they were not able to get a full normal feed, and it was at once recognised that the digestion of such meals was abnormal. In a few instances the flies were fed on dogs, cats and guinea-pigs, but even on such animals the act of feeding did not seem to be quite natural, and often occupied as long as five minutes, whereas on the human body the flies seldom remained longer than one or two minutes, if undisturbed, before flying off fully distended with blood. In the case of the guinea-pigs, the flies showed a curious reluctance to feed even when suffering so severely from starvation that they died a few hours later. The flies were therefore allowed to feed on my own fingers in all the experiments referred to below.

It has been pointed out that movement plays a considerable part in attracting the attention of tsetse-flies, and in his recent report on the Gambia, Dr. J. J. Simpson has given several notable instances of this fact. But whilst it is undoubtedly the case that movement does attract the flies from a distance, I believe that at closer quarters some sense of smell is essential in guiding them. In the glass jars in which I kept my flies, at any rate, as soon as a finger was pressed against the gauze cover the flies came to feed, whereas they ignored any other similar looking body, or even the leg or back of a guinea-pig in the same position. Whether the body applied to the opening was moved about or kept quite still seemed to make no difference.

### *The Act of Feeding of Glossina Palpalis.*

The attitude during feeding is of course well known, the fly standing firmly on all six feet and thrusting its honey-brown proboscis vertically downwards into the skin, whilst the ensheathing palpi project forwards and upwards. As pointed out by Dr. Moiser, the fly sometimes partially withdraws its proboscis and thrusts it in again and again, but once a satisfactory well of blood has been tapped, the abdomen fills rapidly and in from one to two minutes the act of feeding terminates, and the fly, withdrawing its proboscis, moves to one side and presently flies heavily away.

In my experiments I have usually found the bite painless. Sometimes however it was decidedly painful, and I can only account for this by supposing that on these occasions the proboscis entered sufficiently near to one of the sensory spots of the skin to stimulate it. On the other hand there was generally some degree of smarting at the site of puncture after the feed was over, and it is probably this which usually attracts the attention of the victim to the presence of the fly, which having already fed is able to escape on the first indications of uneasiness.

If undisturbed, the fly feeds until the abdomen is relatively greatly distended and of a bright red colour, due to the blood showing through the tense and semi-transparent tissues. The dorsal plates of the abdomen are widely separated, so that the body loses its characteristic dark colour. The appearance is therefore somewhat different from that given in the figure of "A Tsetse fly (*Glossina morsitans*), after feeding" in Mr. Austen's "Handbook of the Tsetse flies" on page 93. To determine the amount of blood actually drawn up, the following experiments were carried out. Two or three tsetse-flies (*G. palpalis*), that from the almost linear dimensions of their abdomens had evidently not been fed for some time, were stupefied with chloroform and in this condition were weighed. They were then allowed to recover consciousness, and when quite restored were fed undisturbed on my fingers. It was noticed that they almost invariably selected the extensor aspect, a precaution that no doubt often saves them from being crushed by a sudden flexion of the finger. They were once again stupefied with chloroform and reweighed. The difference between the two weighings represented the weight of the blood taken up, for sufficient time was not allowed to elapse after the feeding for any exudations to be lost, and in the condition of

stupefaction produced by chloroform the process of digestion appeared to be arrested. The following is an example of one such experiment:—

One male and one female *G. palpalis*, lean and unfed.

| | |
|---|---|
| 12 noon. | Stupefied and weighed—·038 gm. |
| 1.0 p.m. | Flies completely recovered. |
| 1.30 | Allowed to feed on my finger, which they did readily, stupefied with chloroform as soon as they ceased feeding, and weighed —·088 gm. |

Therefore the blood taken up by one fly was :—(·088—·038)÷2, or ·025 gm. As the result of a number of such experiments the average weight of blood ingested by the male was found to be ·027 gm. which, reckoning the specific gravity of normal blood as 1·06, corresponds to 2·5 cmm. Larger numbers of flies were not employed in each experiment owing to the difficulty of getting them to feed simultaneously, and the practical impossibility therefore of preventing some of them exuding drops of fluid before being weighed. The advantage in the reduction of the one source of error would therefore have been overbalanced by the introduction of another.

The weight of the flies varies considerably with the length of time that has elapsed since the last meal, but nevertheless there is an appreciable difference between the weights of the unfed males and females. As a rough average the unfed male weighs ·020 gm., and the female, which is somewhat larger, ·028 gm. The same applies to the fed flies—they do not always engorge themselves to the same extent, but the average weight of blood ingested is somewhat greater in the case of the female. On one occasion as much as ·0485 gm. (or 4·5 cmm.) of blood being drawn up by a female, and ·030 gm. by a male. The proportion is perhaps better stated in comparison with the body weight—a male *G. palpalis* is capable of sucking up blood weighing 1·3 times his body weight, and a female 1·6 times her body weight.

With regard to the frequency with which the flies feed it was generally found that once fed they refused to bite again until about 30 hours had elapsed. But here again the intensity of the last meal has to be taken into account, for on one occasion a fly which had fed very fully refused to feed again until 70 hours later. As the flies were all confined in glass jars containing no water this shows that when fully and naturally fed they are able to live unfed much longer than the 30 hours that is sometimes given as the limit of their endurance under such conditions.

*Digestion.*

Having fed, the tsetse-fly settles quietly to digest. At first the under surface of the distended abdomen is uniformly red in the case of the male, but the female always has a pale opaque spot at the distal end. In from 2 to 5 minutes however a pale bubble appears at the proximal pole situated generally just to the left of the mid line. This bubble shows slight movements of contraction and expansion as though it were influenced by some peristaltic-like action of the bowel, and moves gradually over towards the left side, keeping all the time at the proximal extremity of the abdomen. On dissecting a fly at this stage, the bubble was found to be gaseous, and from the fact that the red tint of the blood lingers along

its edge long after it has faded from the rest of the abdomen, we may surmise that it contains oxygen as a constituent at any rate. Two other processes are meanwhile observed to be going on, namely, the exudation of drops of fluid from the anus, and a darkening of the ingested blood.

It is not until 2 or 3 minutes after the fly has settled down to digest its meal that drops of fluid begin to be extruded from the anus. The first drop is often, though not invariably, of a buff colour and turbid, but the succeeding drops are of clear water-like fluid and are of the size of a pin's head. For about 20 minutes they are exuded at intervals varying from 15 to 75 seconds, the intervals being somewhat longer towards the end of this period. Thereafter no more drops are ejected for several hours, and those that follow are of a thick chocolate brown excrement, which on microscopical examination is found to be composed of little rounded bodies, staining a rich purple with Giemsa's solution, and varying in size from mere dots to discs a third the size of a red blood corpuscle. Around many a more or less disintegrated shell can be made out which is probably the remains of an erythrocyte. Coincident with the extrusion of these drops, which are presumably the fluid constituents of the blood, there is a marked shrinking in the size of the abdomen.

Soon after digestion has begun the appearance of the blood in the distended abdomen of the fly begins to change. Commencing at the distal end and spreading upwards the abdomen loses its bright red colour and gradually darkens, so that in from 20 minutes to half an hour the last tint of red has gone. The last part to darken is a narrow zone around the gaseous bubble, and as has been suggested above, this may be due to the presence of free oxygen in it.

Slight differences were observed in the case of the female *G. palpalis*. When fully distended with blood her abdomen appeared to be deeper, or less dilated laterally, than in the case of the male, and the process of darkening of the ingested blood was considerably more rapid. In one case the last trace of red colour had disappeared from the abdomen in 10 minutes. During the insensibility induced by chloroform the processes of digestion seemed to be arrested, no drops of fluid were exuded until consciousness began to return, and it was often as long as an hour before the last tint of red had left the abdomen. The blood in one fly dissected was found to be perfectly fluid half an hour after it had been ingested.

## The Influence of Colour on Glossina Palpalis.

Having previously ascertained that, in the case of the male *G. palpalis* confined in a glass jar without water at a temperature of 40°–41° C. (104°–105·8° F.), whereas exposure to direct sunlight was rapidly fatal, a similar result was only produced after an hour's exposure if the jar was shaded from the direct rays by a covering of thick brown paper, some experiments were carried out to determine whether under similar conditions different colours would produce different results. Male *G. palpalis* flies were therefore exposed to a temperature of 40°–41° C. in glass jars shaded respectively with red, green, blue and yellow paper covers. No water was present in the jars. In the case of the red, yellow and blue covers, after an hour's exposure the flies seemed to be none the worse, and remained very active

throughout the experiments. In the case of green however, after an hour's exposure the fly was showing evident signs of distress, and by continuing the experiment for a further 18 minutes he was killed. The details of this experiment were :—

Male *G. palpalis*, unfed, in jar shaded by an apple green cover. No water. Temp. of air—32° C.

| | | |
|---|---|---|
| 1.15 p.m. | T. 41° C. | Fly introduced. Active. |
| 1.30 | T. 41 | Fly active. |
| 1.45 | T. 40 | Do. |
| 2.0 | T. 40·5 | Fly quiet on floor. |
| 2.5 | T. 41 | Do. |
| 2.10 | T. 41 | Do. |
| 2.15 | T. 41 | Fly fell over on to his back, but got up again at once when the jar was gently shaken. |
| 2.20 | T. 41 | Fly quiet on floor. |
| 2.25 | T. 41 | Hardly able to stand. |
| 2.30 | T. 40·8 | Fly "as if dead." Slight movements of the proboscis only. |
| 2.33 | T. 41 | These movements ceased. Proboscis depressed. Fly removed to a box at the temperature of the external air, but he was dead. |

Bearing in mind the rapidly fatal result of exposure to direct sunlight, it is rather remarkable that in the semi-darkness of the jars shaded by thick brown paper a temperature of 40°–41° C. should have had a more serious effect on the tsetse-flies than in jars shaded by the various coloured papers. In one typical experiment with a fly in a jar shaded by thick brown paper signs of distress were noticed after 35 minutes, and the fly was dead after a further exposure of 25 minutes.

Zungeru, January, 1912.

# NOTES ON THE MOSQUITOS OBSERVED AT BOLE, NORTHERN TERRITORIES, GOLD COAST.

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Bole is a small town situated just north of the 9th parallel N. lat. and about 15 miles from the Black Volta, which forms the western boundary of the Northern Territories of the Gold Coast.

The town lies in a basin-like depression surrounded by ironstone ridges which rise to a height of 300 to 400 ft. above the bottom of the valley; a less elevated spur projecting into the depression from the north-west gives the valley the shape of a crescent. Bole is built at the foot of this spur very near the centre of the concavity of the crescent. During the rainy season the water drains off the surrounding ridges and collects in a swamp, which, following the contour of the valley, forms a crescent round the town; this swamp persists for about seven months of the year, from the beginning of June to the middle of December. Along the edges of the swamp and around either end the natives have dug numerous water-holes. Many of these were made a generation ago when the town extended over a larger area than it does at the present time, and though no longer used by the natives they have not been filled in, so that they form ideal breeding pools for mosquito larvae. The majority of these water-holes are circular in shape, from 3 to 6 feet in diameter and 3 or 4 feet in depth; usually they contain perfectly clear water and frequently have masses of algae growing in them. The country in the Bole valley is covered with orchard bush and grass; many of the water-holes have been dug at the base of trees, while towards the latter end of the rains the grass has become so long as to overhang others, so that excellent shade is afforded for the growing larvae.

In addition to the water-holes there are several borrow-pits from which the mud to form the huts of the town has been taken; these are much larger than the water-holes, being 20 to 30 yards in circumference and 3 to 8 feet in depth. All these borrow-pits become filled with water during the rains, and this water is more liable to contamination by animal excreta, as, owing to the less steep banks, cattle prefer to drink at these pits rather than at the water-holes. The surface of the water in the borrow-pits is usually covered with a luxuriant growth of a certain plant which has succulent green leaves and trailing roots.* As explained subsequently, in my notes on *Mansonioides uniformis*, the plant appears to play an important part in the development of the larvae of this mosquito. A single plant may attain a diameter of five inches and have roots six inches long; it therefore provides admirable shade for the developing larvae where there are no overhanging trees or grass.

Samples of water were taken twice weekly from several of the water-holes and from the borrow-pits from the middle of June to the end of December, and the

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* [Mr. E. G. Baker, of the British Museum, has kindly identified this plant as *Pistia stratiotes*, L., an Aroid which is widely distributed through Asia and Africa.—Ed.]

larvae collected from these samples were bred out after separating the species, so far as possible. Many of the larvae were easy to rear, so long as they were given fresh water from their native pool frequently, and care was taken to remove the larvae of other aquatic insects, such as dragon-flies, which prey upon them. Other larvae did not thrive so well; for example, quite two-thirds of the *Myzorhynchus* larvae died after living several days in the breeding vessels without appearing to grow at all.

The station at Bole is distant about 600 yards north of the town and some 500 yards from the nearest water-holes, although at the height of the rainy season a small marsh forms within 100 yards of the quarters, in which larvae of *Myzomyia funesta* have been found.

A collection of mosquitos which found their way into the Medical Officer's quarters was made and in the order of frequency of their occurrence these appeared to be:—(1) *Mansonioides uniformis*, (2) *Culiciomyia nebulosa*, (3) *Myzomyia funesta*, (4) *Myzomyia costalis*, and (5) *Stegomyia fasciata*.

Examples of all the species bred were sent to the Entomological Research Committee, and I am much indebted to Mr. F. W. Edwards, of the British Museum, for kindly identifying them.

*Notes on the early stages.*

1. **Myzorhynchus mauritianus**, Grp. and **paludis**, Theo.

Larvae found from June to December in water-holes shaded by overhanging grass or having water-weed growing on the surface; also found at the edges of the swamp. The larvae may be very dark grey in colour, showing lighter bands, or a beautiful grass-green, when the palmate hairs may be easily seen with the naked eye. When the larvae are dark in colour, the pupae are also dark; and similarly when the larvae are green, the pupae are green.

I have been unable to distinguish between the larvae of *M. mauritianus* and *M. paludis;* and it appears to me also that in the perfect insects specimens may be found that are intermediate between the two forms.

These larvae are difficult to rear in artificial conditions, and quite two-thirds of them died before pupating.

2. **Nyssorhynchus squamosus**, Theo.

Larvae found in water-holes containing clear water overhung with grass, from September to December. The larva is of a green colour and resembles that of *N. watsoni*, Edw., but has palmate hairs on segments 2–7 (rudimentary on 1st). Pupa of a green colour.

3. **Nyssorhynchus watsoni**, Edw. var.

Larvae found from September to December in shaded water-holes which often contained filmy algae. The larva is green in colour and resembles that of *N. squamosus*, but may be distinguished with a pocket-lens, as it has palmate hairs only on segments 3–7 and these are like the palmate hairs of *M. paludis* to some extent. The pupae are green and not distinguishable from those of the preceding species.

4. **Myzomyia funesta**, Giles.

The commonest Anopheline larva, found in almost all water-holes containing clear water, and also in the swamp. It occurs from June to December, but is commonest in August and September. Both larva and pupa are almost black in colour, though the pupa when first hatched shows transverse lighter bands and the larvae may show white markings on the thorax and abdomen.

5. **Myzomyia costalis**, Lw.

Larvae found chiefly in one water-hole containing opalescent water, but at the height of the rains they were found in the hoof-marks of cattle and in puddles containing muddy water in the neighbourhood of the swamp. They were common from June to September, almost absent in October, and occurred rarely in the larger water-holes during November and December.

6. **Stegomyia sugens**, Wied.

Larvae very common in shallow rock-pools throughout the rainy season; after the middle of October they were found scantily in some of the water-holes. Both larvae and pupae are very dark in colour, approximating to the colour of the bottom of the rock-pools.

7. **Stegomyia fasciata**, F.

The larvae of this species were found in native water-holes from June to December.

8. **Ochlerotatus nigeriensis**, Theo.

The larvae were only found for two days during November in a muddy pool formed by a shower of rain. They looked like the larvae of *Stegomyia sugens*, but as the larvae of that mosquito usually occurred in clear water, they were collected and bred out. The larva is very dark in colour and has only a short siphon-tube; the pupa is also dark, and active.

9. **Aëdomyia catasticta**, Knab.

Larvae found in a borrow-pit containing clear water, overgrown with the same water-plant [*Pistia stratiotes*] which serves as a protection for *Mansonia* larvae; September to December. If disturbed when in a glass vessel the larva descends to the bottom and will remain below for many minutes, lying with the ventral surface uppermost, seemingly balanced on its siphon-tube and the dorsum of its thorax; it appears to feed in this position. The pupa shows a curious chequered pattern on the thorax when newly formed.

10. **Mansonioides uniformis**, Theo.

Larvae only found in borrow-pits containing fairly clear water, overgrown with a water-plant [*Pistia stratiotes*]. To secure the larvae it was necessary to scoop up pieces of the plant in the dipper and shake these vigorously before extracting them from the water; the larvae were then readily picked out from the sediment which settled at the bottom of the dipper.

The larvae are pearl-grey in colour, with a peculiar conical black-tipped siphon-tube and a longish anal segment, with dorsal and ventral plumes extending outwards almost at right angles, giving it a T-shaped appearance. They progress with a wriggling movement like a *Stegomyia* larva.

Placed in a glass vessel containing water and the water-plant from their native pool the larvae may be watched attaching themselves by their siphon-tubes to the roots of the plant below the surface of the water. Having attached themselves they will remain under water for an indefinite period ; I have watched larvae in the same position for 45 minutes. Owing to the roots of the plant and the larvae being almost alike in colour the latter are not easily recognised when attached, and the plant may be readily lifted out of the water and replaced without detaching the larvae, a fairly vigorous shaking being needed to induce them to let go their hold. Like that of *Aëdomyia catasticta*, the larva of *Mansonioides* frequently feeds with the ventral side uppermost. Occurrence—June to December.

The pupae are capable of bringing their trumpets together like a pair of pincers, and they also grasp the roots of the plant by means of these. They do not remain below constantly like the larvae, but when once attached a vigorous shaking is needed to displace them, as in the case of the larvae.

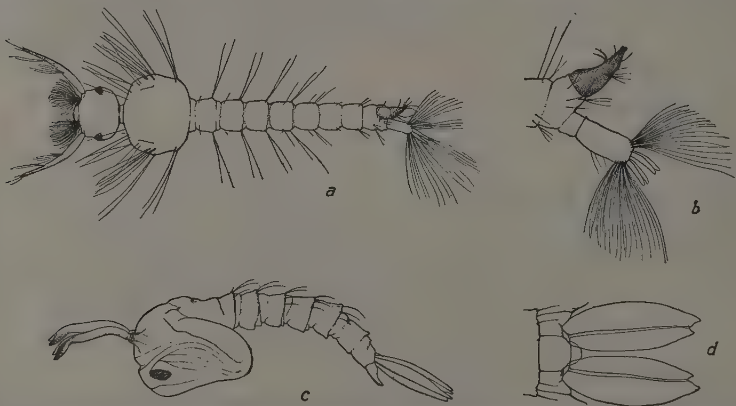


Fig. 1.—Early stages of *Mansonioides uniformis*, Theo. ; (*a*) larva, dorsal view ; (*b*) terminal segments of larva ; (*c*) pupa, lateral view ; (*d*) anal plates of pupa.

The following is a detailed description of the larva :—

Pearl-grey in colour, and about 4 mm. long. The head is large, but not so wide as the thorax ; the antenna has a dark plume of plumose hairs about one-third of its length from the base and two stout bristles at two-thirds of its length ; there are two short terminal hairs and a blunt stout bristle at the apex. The brushes are well developed and the face shows plumes. The thorax has the usual plumose hairs.

The siphon-tube is conical in shape, and rather more than twice as long as broad ; its apical third is very dark and highly chitinised, appearing to be movable on the basal portion. At the junction of the dark apical portion, on the dorsal surface, are two stout curved bristles terminating in sharp points, while on the ventral surface there are two dark straight hairs. A crown of hooklets surrounds the orifice of the siphon-tube, those on the dorsal aspect frequently having two belts. In imperfectly cleared specimens these hooklets appear to be

connected with rods passing through the dark portion of the tube; as muscular bands pass up the basal portion of the tubes, possibly the hooks are capable of being extruded and retracted. The dark portion of the siphon-tube also exhibits a peculiar serrated outline on the dorsal aspect, when seen from the side, and there is a corresponding but much finer grooving visible on the ventral aspect in one of the specimens, suggesting that this apical portion of the tube may be bent dorsally. The siphon-tube has a plume of simple hairs half-way up on either side; there is also a subsiphonal plume of simple hairs. The comb is curious, consisting of only two stout blunt-ended bristles.

The anal segment is about as long as the siphon-tube, and has a stout ventral beard of simple hairs and well developed plumes on the dorsal edge. There are, in addition, four tufts of hairs along the ventral aspect, and four short anal papillae.

The mature larva shows on the ventral surface two very stout, highly chitinised hooks, which are evidently the hooks which are visible within the trumpets of the pupa and by means of which it (the pupa) attaches itself to the roots of the water-plant, as mentioned already.

11. **Culex quasigelidus**, Theo.

Larvae found from October to December in borrow-pits containing clear water, overhung with grass and covered with algae. The larva is banded alternately light and dark; the pupa very dark. This species is difficult to rear in artificial conditions; it takes long to pupate and the insect often fails to emerge from the pupal case.

12. **Culex ager**, Giles, var. **ethiopicus**, Edw.

Long-siphoned larvae of a green colour, found in water-holes containing clear water, in which were floating semi-submerged, filmy algae (*Spirogyra ?*). June to December. The pupae have forwardly-directed trumpets with large openings.

13. **Culex duttoni**, Theo.

These larvae were obtained in many of the water-holes which contained somewhat foul water; they were also to be found in domestic cooking utensils whenever water was allowed to accumulate in them for a few days. Occurrence—June to December.

14. **Culex annulioris**, Theo.

The larvae occur in clear water, containing filmy algae, and are green in colour with a long siphon-tube; they are difficult to distinguish from the larvae of *Culex ager*, with which they are often found. Occurrence—July and December. The pupa has forwardly-directed trumpets with a large aperture.

15. **Culex univittatus**, Theo.

The commonest Culicid larva, found in nearly all the water-holes from June to December. The pupa is small, with the sides of the thorax almost parallel.

16. **Culex invidiosus**, Theo.

Larva chiefly found in July, August and December; it has a superficial resemblance to that of the preceding species. The pupa is larger than that of *C. univittatus* and has the sides of the thorax rounded.

17. **Mimomyia hispida**, Theo.

The larva of this species was not recognised. Pupae were found in November in the same borrow-pit as the *Mansonioides* larvae. They have rather long curved trumpets, directed forward, the tips of which are pale; the anal plates are dark and show spines and a white spot like the pupae of *M. mimomyiaformis*.

18. **Mimomyia plumosa**, Theo.

Large larvae, found only for one week during November, in the same borrow-pit as the *Mansonioides* larvae. These larvae were very scanty. The pupa has curved, forwardly directed, long trumpets, with a white apical piece; the anal plates are dark with a white spot, as in *M. hispida*.

19. **Mimomyia splendens**, Theo.

The larvae are like those of *Ingramia malfeyti*, Newst., but larger, having a dark head and dark thoracic plumes. They were found in borrow-pits covered with water-plant [*Pistia*] during October, November and December. The pupa has long, straight, dark diverging trumpets, and is green in colour.

20. **Ingramia malfeyti**, Newst.

Small larvae, found in most of the water-holes containing clear water with plenty of shade, from June to December, but at no time very numerous. The larva has a dark head and long black thoracic plumes, but is otherwise of a very pale green colour. The pupa is also pale green in colour and very active.

21. **Uranotaenia balfouri**, Theo.

A very short-siphoned larva (with marked stellate hairs) found scantily from June to December; commonest in August, in certain water-holes containing water of a yellowish tinge and often having an iridescent surface film. The larva is dark, with a rounded black head and thorax. The pupa is small and dark brown in colour. The species is difficult to rear in artificial conditions.

[In addition to the foregoing, Dr. Ingram has also succeeded in breeding the following species :—*Culex tigripes*, Grp., *C. grahami*, Theo., *C. argenteopunctatus*, Vent., *Culiciomyia nebulosa*, Theo., and *Mimomyia mimomyiaformis*, Newst.—Ed.]

# A NEW WEST AFRICAN SPRINGTAIL.

By Professor George H. Carpenter.
*Royal College of Science, Dublin.*

Among various insects collected on behalf of the Entomological Research Committee by Dr. R. W. Gray in Southern Nigeria, a large number of minute Collembola, all belonging to the same species, and taken at Benin City on June 9th, 1910, have been sent to me for identification. So little is known of Tropical African Collembola, that no surprise could be felt when the insect proved to belong to an undescribed species. Dr. Gray gives no information as to the kind of locality in which this springtail was found, or whether it was in any way injurious. In Europe, however, in recent years, students of economic zoology have come, more and more, to recognise that many species of Collembola feed on living plant tissues [1] as well as on the decaying vegetable and animal refuse which forms the usual food of their order. It seems fitting therefore that an account of the insect should be published in this Bulletin, if only to call the attention of entomologists working in Tropical Africa to the scientific interest, and probable economic importance of springtails.

## Order COLLEMBOLA.

### Family Entomobryidae.

### Sub-family **Isotominae.**

The new species from Benin belongs to the genus *Isotoma* in its older and wider sense. This exceedingly widespread genus (represented in Franz Josef Land and South Victoria Land) includes springtails of typical build without scaly covering, with the third and fourth abdominal segments approximately equal in length, and with simple, ovoid, post-antennal organs on the head. As the fifth and sixth abdominal segments are fused together, and the abdominal sensory bristles simple, this species falls into the sub-genus *Isotomina*, as distinguished by Börner.[2] In a paper on African Collembola,[3] the same writer mentions the absence of records of *Isotomae* from Central and Southern Africa. Wahlgren [4] has however described *Isotoma lineata* from Cairo, and *I. bituberculata* from Khartum. Neither of these is closely allied to the present species, having the sixth abdominal segment distinct from the fifth.

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[1] F. V. Theobald. "'Springtails' (Collembola). Their economic importance, with notes on some unrecorded instances of damage." 1er Congrès International d'Entomologie (Bruxelles, 1910), vol. ii, pp. 1–18, pls. i.–iii. Also in "Report on Economic Zoology" for year ending September 30th, 1910, S. E. Agricultural College, Wye.

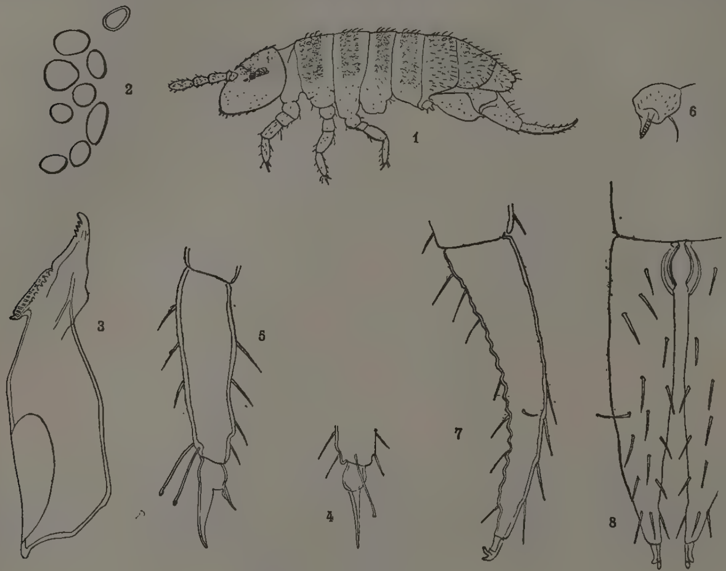
[2] C. Börner, "Neue altweltliche Collembolen, nebst Bemerkungen zur Systematik der Isotominen und Entomobryinen," Sitzsb. Gesellsch. Naturforsch. Freunde, Berlin, 1903, pp. 129–182.

[3] C. Börner, "Collembolen aus Ostafrika, Madagascar und Südamerika" (in Voeltzkow's Reise in Ost-Afrika, Bd. ii.), Stuttgart, 1907.

[4] E. Wahlgren, "Apterygoten aus Aegypten und dem Sudan" (in Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901), Upsala, 1906.

**Isotoma (Isotomina) fasciata,** sp. nov. (figs. 1–5).

Length ·7 mm. Feelers as long as head; second and fourth segments subequal, third somewhat shorter. Eight ocelli on each side, the inner anterior two larger than the others; post-antennal organ broadly oval, slightly less than a large ocellus in diameter (fig. 2). Front foot with one tenent hair (fig. 4), hind-foot with two (fig. 5). Foot-claw untoothed, slender and slightly curved; empodial appendage short, tapering, with very narrow lamella. Fourth abdominal




*Isotoma fasciata*, sp. nov.

(1) side-view of insect, × 75; (2) ocelli and post-antennal organ of right side, × 470; (3) mandible, × 470; (4) tip of fore-foot with claw, × 470; (5) tibio-tarsus of hind leg, × 470; (6) catch, × 470; (7) dens and mucro, side-view, × 470; (8) dentes and mucrones, dorsal view, × 470.

segment $1\frac{1}{4}$ times as long as third (fig. 1). Catch with bristle on basal segment (fig. 6). Spring with dens and mucro nearly half as long again as manubrium (fig. 1). Mucro short, with terminal, dorsal, and lateral upturned teeth (figs. 7, 8).

Colour white, with bright blue transverse bands on the thoracic and abdominal segments, and blue markings on the feelers and head.

Southern Nigeria: Benin; numerous specimens collected by Dr. R. W. Gray, June 1910.

*Types* in the British Museum.

# THE TRANSMISSION OF PATHOGENIC MICRO-ORGANISMS BY FLIES IN SAINT LUCIA.

By Lucius Nicholls, B.A., M.B., B.C. (Cantab.).

The mechanical conveyance of germs by flies and other insects is of importance not only to the sanitary officer, but to the agriculturist and even to the merchant, for the more the matter is enquired into, the more numerous become the cases in which the origin of fermentation or disease in plants and animals can be traced primarily to this agency. Whatever may be the significance of this question in temperate climates, it is obviously of far greater importance in the tropics, where insects are present in greater profusion throughout all seasons of the year. The subject certainly merits more attention than has yet been bestowed upon it.

Flies undoubtedly play an important *rôle* in those countries in which dysentery, typhoid, cholera, yaws, ulcers, intestinal worms, &c., are common; and when we consider how often tubercle bacilli are found in the faeces of tuberculous patients, it is quite possible that even such a disease as this may at times be conveyed to the uninfected by the agency of these insects.

The insects which come in contact with, and find nutriment in, human excrement, obviously demand considerable notice from those engaged in the study of sanitation. The degree of importance of each species in this respect varies within wide ranges and is dependent upon a number of factors. The flies undoubtedly head the list, for although there are a number of other insects, such as ants, Psocidae and Coleoptera, which are also found in these surroundings, they are not usually so likely to be a danger to man by coming in contact with his food and water supply.

In tropical countries where the lower classes are often unacquainted with the use of latrines, swarms of flies are bred in the faecal deposits; some of these will be found upon food, and in dry weather numbers will be found flying around pools and water supplies, and can be observed alighting at the edge of the water to drink. Some of these species for filthy associations far surpass the common house-fly (*Musca domestica*), which rarely, if ever, is found breeding in human stools, and which does not naturally seek this matter when there is an abundance of other food. Some species have become adapted to breeding in this situation and are not found elsewhere.

*Musca domestica* is not well adapted for experiments to discover the exact relationship of micro-organisms to flies, on account of difficulties in breeding it. Many other species are far more favourable for this work. I have now carried out in Saint Lucia numerous experiments with flies and pathogenic organisms in the attempt to ascertain how long flies are likely to be infectious and whether the infection is present through more than one stage of their life-history. The germs used were the typhoid bacillus and several others of those that do not ferment lactose, besides such organisms as *Bacillus prodigiosus* and *Staphylococcus pyogenes* var. *aureus*.

The experiments were conducted by exposing human stools in various places on different days for about ten hours, after which time it would be found that

numerous ova and larvae of flies had been deposited upon them. In all, twenty-five masses were used and approximately 18,000 flies hatched out, excluding winged and wingless PHORIDAE, which formed a later batch; this gives an average of 720 for each stool. The flies comprised only the following six species, which have been kindly determined by Mr. E. E. Austen, of the Entomological Research Committee.

DROSOPHILIDAE.
*Drosophila melanogaster*, Mg.
BORBORIDAE.
*Limosina punctipennis*, Wied.
SEPSIDAE.
*Sepsis sp. inc.*

TACHINIDAE.
*Sarcophaga aurifinis*, Walk.
*Sarcophaga sp. inc.*
*Sarcophagula sp. inc.*

The *Sepsis* was very numerous on all occasions. The *Drosophila* does not usually breed in this situation; its larvae can be found in all kinds of fermenting or decaying fruit and vegetables. It has some connection with the fermenting of cocoa, and during the cocoa crop or the mango season it occurs in large swarms. Numbers of them are found in houses in the country, where they settle on


Fig. 1.—*Drosophila melanogaster*, Mg. × 16.

all forms of food or drink, and they are also found swarming round latrines in search of undigested vegetable matter. The *Limosina* is by far the most objectionable of them all, as on every occasion on which it was caught its abdomen was found to be distended with pure faecal matter. In 26 out of 100 specimens, taken in different situations, I have obtained the ova of the worms, *Ascaris lumbricoides*, *Necator americanus*, or *Trichocephalus dispar*.

All the above three species lay eggs which they force into the faecal matter, two prolongations of the egg-covering alone protruding. The larval period is short and followed by a longer pupal period.

All the Tachinids deposit comparatively large living larvae, which immediately crawl into the mass; again the pupal period is longer than the larval. In 15 pregnant females of the *Sarcophagula* dissected, the lowest number of larvae found was eight and the highest 21.

One characteristic of the larvae of these six flies, which is of considerable importance, is that they all attempt to get well away from their breeding ground to pupate in the bush, or under stones and other objects in the neighbourhood. The larva of *Limosina punctipennis* possesses the "hold and let go" mechanism for this purpose, so that by uniting its head and tail ends and then abruptly straightening itself out, it is able to hurl itself well clear of its breeding ground.

The following table summarises a few points observed in connection with the six species under consideration.

| —— | No. of times found in 25 inspections. | Egg or larva deposited. | Larval period. | Pupal period. |
|---|---|---|---|---|
| *Sarcophagula sp.* ... | 24 | larva | 3–5 days | 5–7 days |
| *Sarcophaga sp.* ... | 18 | larva | 5–7 days | 6–9 days |
| *Sarcophaga aurifinis* ... | 22 | larva | 8–11 days | 10–13 days |
| *Sepsis sp.* ... ... | 25 | egg | 3–4 days | 2–4 days |
| *Drosophila melanogaster* | 1 | egg | 2–3 days | 3–5 days |
| *Limosina punctipennis*... | 25 | egg | 2–4 days | 2–5 days |

The undetermined *Sarcophaga* and the *Drosophila* are frequently found upon food, and the others, with the exception of the *Sepsis*, have occasionally been found upon provisions in houses. They are all of them liable to infect water supplies, especially in dry weather.

## Experiments to elucidate the relations of larvae and pupae of the flies to micro-organisms.

### *Experiment I.*

(A.) Twelve larvae of the *Sarcophagula*, which had just left faecal matter to find a protected situation in which to pupate, were placed in a sterile vessel for two hours to allow digestion and natural cleaning processes to proceed. They were now each in turn seized with forceps and the two ends snipped off with sterile scissors; these cut surfaces were now burnt with a hot needle to sterilize them, and a serrated platinum needle was passed through one of these burnt ends, the interior of the maggot being removed and transferred to five cubic centimetres of sterile peptone broth. This was then ground up with a glass rod and a number of plate cultures were taken from a definite quantity of the preparation. In the 12 cases the number of micro-organisms which grew as colonies varied, but not more than 31 per cent. from the two middle numbers. The total number of colonies for the twelve maggots were reduced to the number 100.

(B.) Twelve pupae approximately 24 hours old were taken and similarly treated as the larvae in (A.). The numbers of their colonies were compared with the numbers in (A.) and gave 26 per cent.

(C.) Twelve pupae approximately 48 hours old were then taken and gave five per cent. of (A.).

(D.) Twelve pupae approximately four days old gave a result of less than 0·4 per cent.

(E.) Another 12 pupae which were about to hatch out gave the following colonies for two and a half cubic centimetres of the broth:—Five pupae gave between 10 and 40 colonies; seven pupae gave less than 10 colonies, and of these two gave only two colonies each, and another was sterile.

There are certain possibilities of error in this experiment, but it is at least sufficient to show definitely that during development the fly possesses very great powers of destroying micro-organisms. The experiment when repeated with another species of fly (*Sarcophaga*) gave similar results.

### *Experiment II.*

A number of faecal masses were mixed up with emulsions of *Bacillus typhosus*, or an organism of this group which did not ferment lactose and which I had recently isolated from a stool, or *Bacillus prodigiosus*, or *Staphylococcus pyogenes* var. *aureus*. They were now exposed to flies and attempts made to trace the organisms through the resulting larvae and pupae.

When the organism could be isolated from the breeding material it could be isolated from the larvae if they were used at once, but even in the faecal matter these organisms became progressively less, though I obtained the typhoid organism for 17 days, using the malachite green method.

If the larvae were removed for a few hours before experimenting with them, the germ could not always be grown. Thus, after four hours the typhoid bacillus was obtained five times in 12 attempts; *Bacillus prodigiosus* was obtained twice and the *Staphylococcus* seven times. In none of the experiments did I succeed in isolating any of these organisms from the interior of a pupa.

### *Experiment III.*

(A.) A very large number of pupae were transferred to a sterile glass basin. On the day that the flies were due to hatch out they were carefully examined; one or two were seen to be about to hatch out; these were removed, and as the head of the fly appeared it was seized with sterile forceps, pulled out, and placed in peptone broth, and from this plate cultures were prepared. In all, 12 flies were examined; from 10 one or two colonies grew; two were sterile.

(B.) Recently hatched-out flies which had not fed were transferred to a dry sterile vessel for two days, then they were chloroformed, the heads and ends of the abdomen were snipped off, the interior extracted and smeared upon agar-agar. Not in one of 12 cases did a single colony appear.

This complete sterility of starved newly hatched flies appeared so extraordinary considering their recent associations, that another series was used, a different fly (*Sarcophaga*) employed and killed by smashing the head between forceps, to eliminate the possible action of a killing vapour. Ten out of the 12 were sterile to agar-agar, and only a few colonies appeared in the other two cases.

Thus, with flies hatching out from faecal matter, there are two important points:—

(1) their moving away from the matter in order to pupate; (2) their power of destroying micro-organisms during their development.

Therefore, for practical considerations, as regards the conveyance of organisms causing disease, a freshly hatched fly may be considered as probably sterile,* and there is not much likelihood of its acquiring these organisms by contact with the material in which it bred.


Fig. 2.—*Sarcophaga aurifinis*, Walk. × 6.

## Observations on the transmission of micro-organisms by adult flies.

The period of the infectivity is very different during the imaginal stage of the fly.

If the common house fly (*Musca domestica*) is placed in a cage and its food infected with an organism, this organism can easily be isolated from the fly for 24 hours afterwards, but it will be found that this period of starvation has greatly reduced the number of organisms in its intestinal tract.

I have elsewhere described an experiment with the "ulcer fly" (*Oscinis pallipes*, Lw.), in which the fly was fed upon pus from a boil caused by *Staphylococcus pyogenes* var. *aureus*, and this organism was cultured from the fly 24 hours after it had fed. I believe that the majority of cases of yaws (framboesia) in the West Indies are caused by the inoculation of surface injuries by this fly. They feed only on the skin discharges of man and other animals, and though rare in the town of Castries, they are very numerous in the country districts of St. Lucia, and can be seen hovering round the bare legs and arms of labourers, searching for abrasions or the secretions of the sweat and sebaceous glands. The persistence of these little flies is extraordinary ; they must be brushed off by

* [Mr. A. Bacot has recently proved (*cf.* Proc. Ent. Soc. Lond. 1911, p. 497) that in the case of *Musca domestica*, if the larva be infected with *Bacillus pyocyaneus*, the infection may be carried right through to the newly emerged imago, positive results having been obtained by him in every instance. In view of this, it seems probable that Dr. Nicholls has under-estimated the significance of the fact that in his experiment with *Sarcophaga* a similar transmission took place in 2 cases out of 12.—Ed.]

actually touching them, and they will immediately return. If undisturbed, they engorge themselves with pus, blood, serum or sebaceous secretion, until their abdomens are greatly distended.

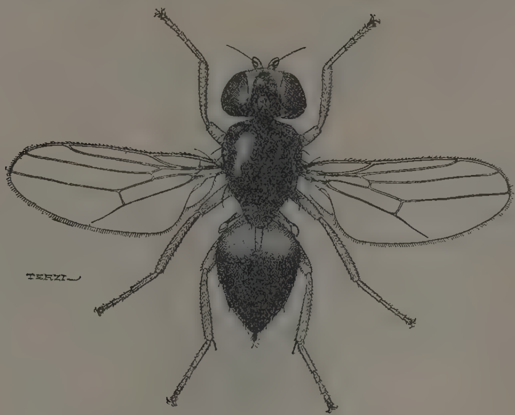


Fig. 3.—*Oscinis pallipes*, Lw. × 16.

The "vegetable fly" (*Drosophila melanogaster*, Mg.) is always found swarming round fermenting cocoa, and I have obtained, by cultures and saccharine medium, the cocoa yeast (*Saccharomyces theobromae*) 24 hours after the fly had fed.

It is extremely difficult to carry on these experiments for any length of time as most flies quickly die in captivity, and naturally, feeding introduces an error, as the fly infects its food and thus reinfects itself.

*Limosina punctipennis** lives and breeds almost exclusively upon human excrement, and in exposed places swarms of this little fly will be found. The only other situations in which I have caught it have been water-pools, rivers, and ravines in very dry weather, when it will fly a considerable distance in search of water. After a long period of dry weather I placed a small pan of water in a patch of "bush" to which labourers were accustomed to resort, and in which these flies were consequently plentiful. Soon numbers of them were seen alighting on the vessel at the edge of the water and drinking; the next nearest water was about 100 yards away, and here also the flies were seen. The pan of water was left here for several hours; it was then removed and examined for faecal contaminations by means of cultures, and *Bacillus coli communis* was obtained. This experiment was repeated upon two other occasions, and in one of these cases the

* [Mr. E. E. Austen has kindly supplied the following note on *Limosina punctipennis*, Wied.:—"This species occurs throughout the Tropics, from Brazil to Formosa. Originally described from a specimen from the 'East Indies,' it has since been met with in South Formosa and North-West India, Java (on excrement, apparently of a monkey :—J. C. H. de Meijere, Tijdschr. v. Ent., LIV, 1911, p. 425), Hawaii (2,000–4,000 ft.), West Africa, Cuba, St. Vincent, and Brazil. Osten Sacken, who found the fly "abundantly in Cuba," and redescribed it under the name *Borborus venalicius*, regarded it as probable that the insect had been carried from Africa to Cuba in slave-ships,—a hypothesis which may be correct, but is naturally incapable of proof."—Ed.]

same organism was grown. Needless to say that both the vessel and the water were sterilised, and control samples were kept in sterilised bottles.

Fig. 4.—*Limosina punctipennis*, Wd. × 16.

It may therefore be concluded from the foregoing that flies are able to carry pathogenic organisms from man to man, and from infected material to human food and water, and infection may be conveyed which was acquired 24 hours previously; but flies cannot carry organisms, which are pathogenic to man but saprophytic to themselves, through their phases of development.

## Some natural enemies.

The amount of flies and other insects destroyed by birds, frogs, lizards and other creatures, cannot be gauged, and the only manner of arriving at some kind of estimate is by examining the stomach contents of a large number of these animals. As a result of thus investigating certain birds, frogs, and lizards, I have come to the conclusion that flies are destroyed in far greater quantities by small frogs and lizards than by birds in this island.

Parasites which appear to harm flies are not numerous. Various acari are found upon them, but the only one which seemed to destroy the life of the insect was a small brown-coloured species which is very common upon the common house fly (*Musca domestica*). Flies sometimes appear to be parasitized by fungi, but this is a subject which requires much further research.

In their larval and pupal stages their worst enemies are ants. If these find a breeding ground they will carry off all the larvae and pupae, and I have lost the entire number in several experiments in this way. Under more natural conditions a number of factors prevent this action of ants from becoming very great.

There are certain very small parasitic Hymenoptera of the family CHALCIDIDAE which are probably of some service in keeping down the numbers of some of the flies here considered. These insects deposit their eggs in the body of freshly

hatched larvae. This appears to have no effect upon the growth and development of the host until it pupates, when the egg hatches and the resultant guest larva undergoes its development at the expense of the pupa. In a number of cases the period of time from laying the egg to the emergence of the Hymenopteron varied from 22 to 28 days. On one occasion 500 pupae of the three Tachinid flies mentioned above were placed in a vessel and 126 female CHALCIDIDAE hatched out.

I have seen a female Chalcid seize a larva of a *Sarcophaga* by her hind legs (fig. 5) and with extreme rapidity arch her body and insert her ovipositor. The egg is now laid (not down the ovipositor) and by means of two mobile organs in connection with the ventral plate, the Chalcid manipulates at the spot pierced by her ovipositor; apparently this is for the purpose of guiding the egg to its


Fig. 5.—Chalcid ovipositing in larva of *Sarcophaga*.

situation. The egg reaches the interior of the host by its own action. In form, it is pear-shaped, with a ductile stalk having a slightly knobbed end. When the egg is first laid the stalk is bent and curved back upon the egg; held and guided by the organs above mentioned it reaches the spot pierced; now the stalk springs out and enters the hole made in the maggot; the contents of the egg gradually travel down the stalk to the knobbed end, and thus, as it were, the egg flows through its own case into the interior of the maggot. I have arrived at this conception of ovipositing from the following facts which I have observed:—(1) Fly seizing maggot and piercing it with its ovipositor—sometimes it pierces the maggot in the interior of the faecal matter; (2) egg bent upon itself and resting on the two organs above mentioned; (3) egg released and straightening and stiffening itself in a very life-like manner; (4) maggots with an egg attached to a segment, the end of the stalk being apparently embedded; (5) the egg gradually becoming smaller, as it is observed under the microscope attached to a maggot.

I have attempted to indicate a large and absorbingly interesting field of useful study, which can be derived from flies which breed in very noisome and objectionable surroundings; probably their breeding places have caused insufficient attention to be paid them.

Castries, Saint Lucia.

# OBSERVATIONS ON THE OCCURRENCE OF GLOSSINA IN THE MONGALLA PROVINCE OF THE ANGLO-EGYPTIAN SUDAN.

By Harold H. King.

*Government Entomologist, Anglo-Egyptian Sudan, Wellcome Research Laboratories, Khartoum.*

(Map.)

The following is a report on the distribution of the tsetse-flies, *Glossina palpalis*, R. D., and *G. morsitans*, Westw., in the Lado District, through which I travelled during the first six months of 1911, together with some brief notes on their bionomics. My route and the localities in which the tsetse-flies were seen are shown approximately on the attached map, and owing to the impossibility of showing them accurately—most of the khors and villages over and through which I passed are not marked on the map—a route report is also appended. From December 30th, when I left Shambe, till March 8th, when I reached Meredi, I travelled in company with El Bimb. C. M. Drew, M.C., and from May 2nd, when I arrived at Kajo Kaji till July 2nd, when I reached Rejaf, I was with El Bimb. C. H. Stigand, Inspector of the Rejaf and southern portion of the Lado District, to whom I am indebted for much valuable assistance.

The only two species of tsetse-fly noted were the two mentioned above, viz., *G. palpalis* and *G. morsitans*.

## Notes on the bionomics of G. palpalis.

This species appears to be equally bloodthirsty at all hours of the day—from dawn till dusk. On dull cloudy days it is not so active, and on such days on khors where it is not very plentiful one may experience considerable difficulty in finding a single specimen. I have noticed, too, that on sunny days when one is being pestered by from 12 to 20 flies, a cloud obscuring the sun will cause the number to decrease to from four to six.

One cannot definitely state that a khor is "fly-free" after having spent merely an hour or two in looking for *G. palpalis*. As an instance of this—I arrived at a khor at 10 a.m. on a cool cloudy day and camped on its bank. I spent a considerable time that day in collecting in the bed of the khor but saw no *G. palpalis*, and it was not until the afternoon of the next day that a single specimen appeared in camp. Doubtless, too, on khors which do not contain water except during certain seasons of the year, one might search in vain for "fly" during the dry seasons. For these reasons I am of the opinion that if one crosses a number of khors during the day's march and finds *G. palpalis* on some of them, one may safely conclude that "fly" also exists on the others, provided that they are of a similar nature to those on which "fly" was actually found.

It is difficult to say what is the greatest distance from its haunts for which this species will follow a man or animal. A mile is certainly within its limit, for on several occasions I have had a specimen follow me for this distance and have then caught it.

I spent a large amount of time on certain khors and rivers on which *G. palpalis* was abundant in trying to find its pupae, but did not meet with much success. At Yei I unearthed three empty pupal cases which I believe to belong to this tsetse, but cannot be certain of their identity until they have been compared with determined specimens. They were all found in light loamy soil, about an inch below the surface, under bushes, in dense shade on a fairly steep bank about six feet above the water.

## Natural enemies of G. palpalis.

The following five creatures were found to prey upon *G. palpalis* in its adult form:—Two birds, a lizard, a spider, and a mantid. I hope to get these determined shortly. I do not think very great importance attaches to any of these natural enemies, for from the observations made it would appear that *G. palpalis* is by no means the exclusive diet of any of them. One of the birds—a Bee-eater—is probably more useful than any of the others and yet *G. palpalis* existed in considerable numbers in the immediate vicinity of a colony of these birds.

## Notes on the bionomics of G. morsitans.

I saw comparatively few *G. morsitans* on this journey and nowhere did it appear in sufficient numbers to constitute a nuisance. As an example of the difficulty of ascertaining whether this tsetse exists in any particular locality unless one has a lot of time to spare, I may mention one instance. On a bright sunny afternoon I was walking along a path and noticed numbers of a species of fly, resembling in the distance *G. morsitans*, sunning themselves on the path. They always flew away on my approach and before I could see what they were, so I netted some and found them to be *G. morsitans*. With the exception of a single specimen which settled on my dog, they made no attempt to obtain blood, although there were a number of natives with me. Had I been walking through grass, off the path, I should probably have been unaware of their presence.

## Distribution of G. palpalis in the Lado District.

As will be seen from the attached map, *G. palpalis* was found on a large number of khors in the Lado District of Mongalla Province. I believe it exists on all the suitable khors in those parts of that district through which I passed, with the single exception of the tract of land lying between the villages of chiefs Hierallah and Miskeen. This tract is some 50 miles across, and is situated partly in the Bahr El Ghazal Province and partly in Mongalla Province. It is fairly high-lying and constitutes a water-shed, being peculiarly interesting from an entomological point of view. It is the origin of many deep gorges which contain small running streams, even at the end of the dry season; and these ravines are the habitat of several species of mosquitos which I have not seen elsewhere. They are heavily timbered and there is also much rank vegetation under the trees, consequently it is comparatively gloomy at the bottom of the gorges even on bright sunny days. Every here and there the streams emerge from the ravines and, shaded by trees and bushes, flow through open country, and in such places they appear to be ideal abodes for *G. palpalis*. I spent many hours collecting

along these streams, both in the gorges and in the open, but did not once see a *G. palpalis*, so am of the opinion that it does not exist there. Why this should be I do not know. I found *G. morsitans* on one occasion in this locality, so the absence of *G. palpalis* is probably not due to the altitude, which, I believe, is not very great.

In the southern part of the Lado District, south of khor Kair, the natives have hitherto been unadministrated in the generally accepted sense of the word. The Belgian Government originally had military posts at Wadelai, Gebel Wati, Dufile and Kajo Kaji, but these had all been withdrawn prior to the country being taken over by the Sudan Government. Even when these stations were occupied, the various tribes and villages appear to have been continually at war with each other, and as a result of this there was little or no intercourse between them, and therefore comparatively little danger of a disease such as sleeping sickness spreading from one locality to another. Now that the district is being brought under control this state of affairs has already begun to change—*e.g.*, natives now wander freely from Kajo Kaji to Dufile, whereas a year ago they would scarcely have ventured an hour's journey from their villages. The importance in this change in the state of affairs is obvious. *G. palpalis* exists on many if not all of the inland khors, and it appears to me that there is a grave danger of the "fly" on these khors becoming infected with *Trypanosoma gambiense.* During my journey through this southern part of the Lado District I saw no native who appeared to be suffering from sleeping sickness and I believe that as yet this disease is non-existent there, though in this I may very possibly be mistaken. Sleeping sickness exists on the east bank of the Nile opposite Sudan territory. There are chiefs who claim villages on either bank of the river in the neighbourhood of Wadelai and naturally it is a common thing for natives to cross from one bank to the other. North of khor Kair, though some distance from it, lies Yei, the centre of the infected area in the northern part of the Lado District. It can be understood therefore how easily sleeping sickness might be carried inland to the country south of khor Kair and the fly there become infected. I would like to draw attention to the advisability of Medical Inspectors being sent at once to this southern part of the Lado District, to ascertain whether sleeping sickness does as yet occur there, so that in the event of their failing to find it, steps may immediately be taken to prevent its introduction.

I believe it is as yet unknown whether *G. palpalis* can act as an agent in the spread of that form of trypanosomiasis among animals known as "nagana." As I have shewn on the accompanying map, I found very few *G. morsitans* south of khor Kair, and certain localities appeared to be quite free from this fly. In these localities—*e.g.*, the neighbourhood of Gebel Wati—there is a considerable number of cattle, and from the condition of these animals when I saw them, I am led to believe that, at any rate, some of these districts are well suited for cattle-raising. In view of the chance that *G. palpalis* may eventually prove to be a host of *Trypanosoma brucei* I would suggest that the introduction into those parts of the Lado District where nagana does not as yet exist, of animals known to have passed through a nagana infected area should be prohibited.

## Route Report.

**Glossina palpalis,** R. D.

Shambe to Naam River Post—none.

Naam River Post to M'volo—none until M'volo was reached, but plentiful there.

M'volo to Yei River near Bufi—none.

Bufi to Injeti Maba—plentiful all along the Yei River.

Injeti Maba to Lorella (Gebel Odo)—found on one khor by Sh. Birre.

Lorella to Luri Rapids—found on khors on road and at Luri Rapids.

Luri Rapids to Wandi—found on all khors except at Arungwa; plentiful on Torre River at Beringi, and on Yei at Wandi.

Wandi to Kapei—found on river.

Kapei to Meredi—found on rivers and khors at Hierallah. None from Hierallah to Miskeen. Found on some khors, and believed to exist on all, from Miskeen to Meredi. Found at Meredi.

Kapei to Yei—found on all suitable khors including Nambiri and Kobwa.

Yei to Lobogo (on frontier)—found on all suitable khors and at Libogo.

Yei to Loka, *via* Ramadallah, Kombe and Pigga—found on all khors to Ramadallah and on the Yei at Ramadallah. Believed to exist on all the khors between Ramadallah and Loka during rains; when I passed the khors were not flowing.

Loka to Kajo Kaji, *via* Lascho, Logo and Wire—found on all suitable khors including the Kidge and Kair.

Kajo Kaji to Dufile, *via* New Dufile—found on most suitable khors, including the Kayu, and on the Nile near mouth of khor Kayu.

Dufile to Kajo Kaji, *via* Ibrahim—On first journey I found it on all khors except high in the hills. On second journey, a month later, by a slightly different route, I found it up in the hills.

Kajo Kaji to Gebel Wati, *via* Wani, Lefere, Lokwe, Alunga, Alcholi, Nyumbe and Aini—found on most suitable khors and rivers. Alcholi is an open grassy plain, with water, and appears to be free from *G. palpalis*. Plentiful on khors and rivers in neighbourhood of Gebel Wati.

Gebel Wati to Wadelai, *via* Alugwe, Atianbo, Babala and Bowar—found on most of the suitable khors.

Wadelai to Dufile (by river)—taken on river up-stream and also down-stream (occasional specimens) to Dufile.

Kajo Kaji to Rejaf, *via* Lado Nyepo and Lado Yungo—found on all suitable khors (including those in the hills behind Lado Yungo) until within two or three hours of Rejaf.

**Glossina morsitans,** Westw.

Shambe to Naam River Post—found from Atamariel to Naam River Post.

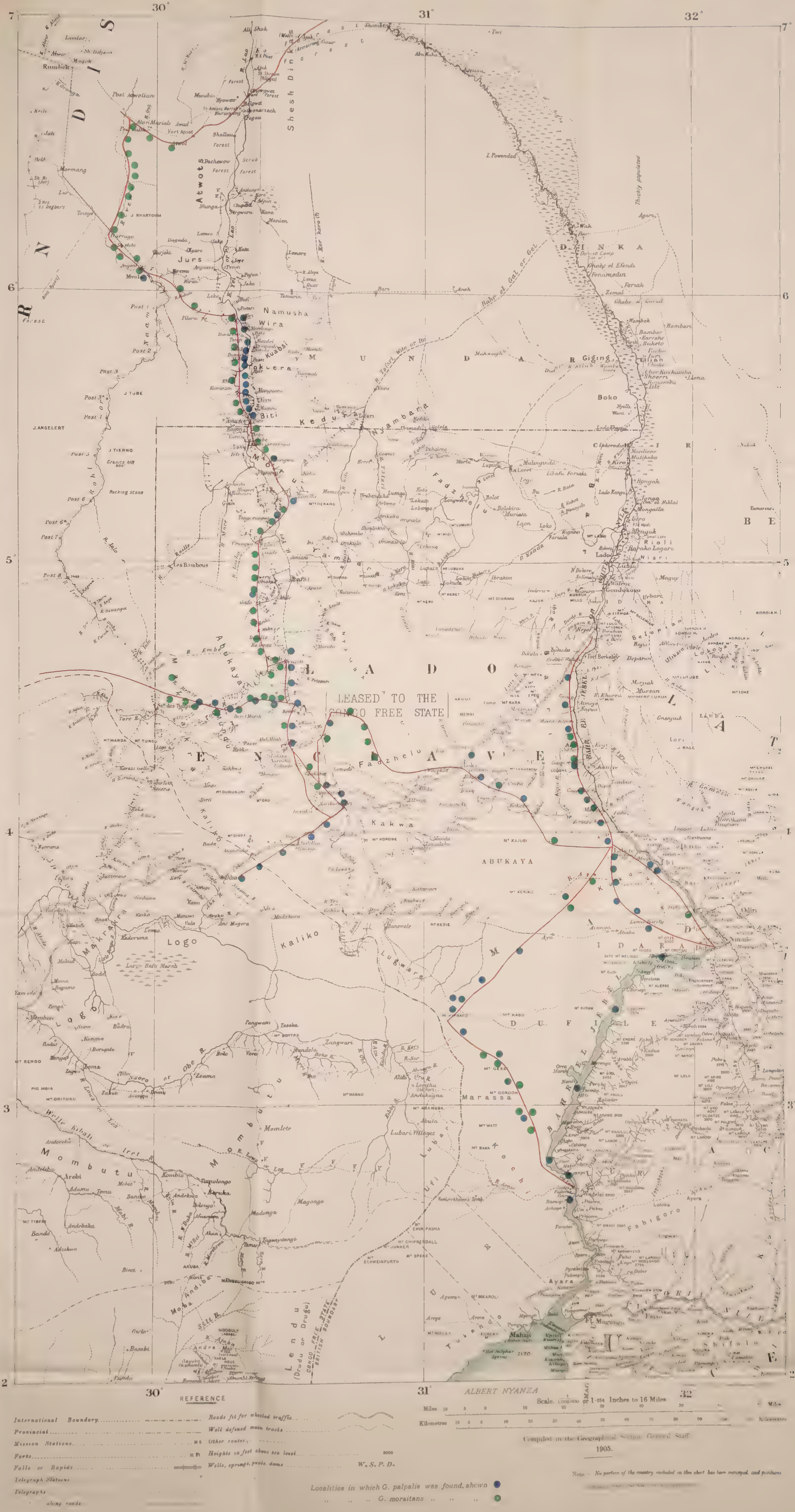
Naam River Post to M'volo—found all the way.

M'volo to Yei river near Bufi—a few seen on the road.

Bufi to Injeti Maba—found all the way.

Injeti Maba to Lorella (Gebel Odo)—found during first two hours.

# SOUTHERN SUDAN.



Lorella to Luri Rapids—none seen until the vicinity of the rapids was reached.

Luri Rapids to Wandi—found all the way.

Wandi to Kapei—none seen, but it has been taken on this road by El Kaim. Percival Bey.

Kapei to Meredi—found all the way to Hierallah, but after that none was seen until within an hour of Bundle's village, when a single specimen appeared; none seen after that.

Kapei to Yei—found by khors Nambiri and Oboa.

Yei to Libogo—none seen.

Yei to Loka, *via* Ramadallah, Kombeh and Pigga—occasional specimens seen all the way until the Gebels near Loka were reached.

Loka to Kajo Kaji—none seen.

Kajo Kaji to Dufile, *via* New Dufile—found between New Dufile and Dufile.

Dufile to Kajo Kaji, *via* Ibrahim—none seen.

Kajo Kaji to Gebel Wati—a single specimen seen between Lokwe and the Koshi River.

Gebel Wati to Wadelai—found from a point 2½ hours south of Alugwe to Bowar. Plentiful in the big swamp through which the Ossa River flows, in the neighbourhood of Babala.

Wadelai to Dufile (by river)—none seen.

Kajo Kaji to Rejaf—found from a point 2 hours south of the Kair khor to the khor.

Khartoum, July, 1911.

# NOTES ON GLOSSINA MORSITANS IN NORTHERN RHODESIA.

By Ll. Lloyd, B.Sc.
*Entomologist to the Luangwa Sleeping Sickness Commission.*

## Temperature in relation to Glossina morsitans.

Roubaud has recently recorded (*cf.* Sleeping Sickn. Bull., III, p. 419) that in West Africa *G. morsitans* is intolerant of high temperatures, as he has found that specimens exposed to 40° C. (104° F.) died within an hour. This species is however adapted to withstand such a temperature in the Luangwa Valley; for during the hot months of October and November the shade thermometer frequently registers from 106° to 108° F., seemingly without any ill results to the tsetses.

## Duration of the pupal period of G. morsitans.

Flies which emerged from pupae obtained in October did so after a pupation period of 23 days, on an average. The approximate mean temperature to which these pupae were exposed was 85° F. The shortest pupation period observed was 21 days, whilst the longest at this temperature was 25 days. Of the apparently healthy pupae obtained during this period 49% died.

## The Dissection of the Salivary Glands of Glossina.

Workers on the transmission of trypanosomes by various species of *Glossina* have hitherto been unable to agree as to the part played by the salivary glands in the process. It is of importance therefore that some method of removing the glands be adopted in which the risk of contamination by gut-contents would be reduced to a minimum. The usual method employed hitherto has been to remove the entire viscera by means of pressure on the abdomen, after either the removal of the last segment, or the severance of the abdomen from the thorax. These methods are open to the criticism that the gut, especially if it contains much blood, is liable to rupture; that the glands are liable to lesion; and that it is very difficult to dissect them free from fat body and gut.

The complete salivary glands may be obtained without risk of rupture of the gut by the following method. *G. morsitans* has been used in the dissections. The fly is held firmly in the hand and a longitudinal incision is made in the median dorsal line of the thorax from the neck to the abdomen. The insect is then immersed in normal salt solution and incisions are made along the transverse groove of the thorax from the median incision almost to the bases of the legs. The strong muscles in the thorax which run in a longitudinal direction should also be severed. A needle is now placed in the anterior end of the longitudinal incision, and another in the posterior end. A gentle longitudinal pull applied to the fly by these needles causes the remainder of the thorax to break across. The alimentary canal breaks between the pharynx and proventriculus, while the salivary glands are drawn out of the abdomen quite free from fat body and with

only the finer twigs of the tracheal system adhering. It is now a simple matter to dissect away the remainder of the thorax and head till a preparation is obtained consisting of proboscis, pharynx and salivary glands. The figure shows the appearance of such a preparation. The glands when first withdrawn are quite transparent and exhibit an active wriggling motion. They correspond exactly with the salivary glands of *G. palpalis* as described by Minchin.* If the pull

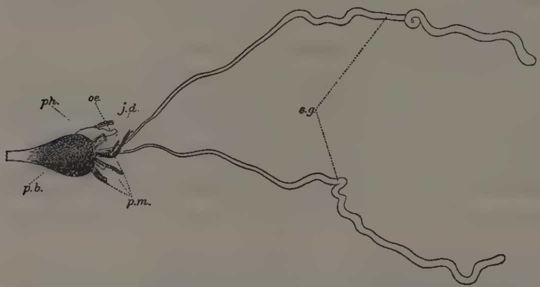



Fig. 1.—Preparation of salivary glands and proboscis of *G. morsitans* (semi-diagramatic). × 10. *s.g.*, salivary glands ; *j.d.*, junction of salivary ducts ; *oe.*, oesophagus ; *ph.*, pharynx ; *p.b.*, bulb of proboscis ; *p.m.*, muscles of proboscis.

on the fly is not perfectly longitudinal, one of the glands may break off just posterior to the junction of the salivary ducts. Occasionally both the glands break away at this attenuated part of the ducts. In either event the remainder of the thorax attached to the abdomen is dissected off and the protruding glands are withdrawn by means of fine forceps. A little dissection of the anterior end of the abdomen is sometimes necessary to effect this.

Another method that has been adopted with some success is to draw the glands out of the fly by means of the proboscis. A longitudinal median incision is made in the thorax as before and the cut is opened out by means of needles with which the structures in the thorax are loosened. The dorsal surface of the head, the eyes and the jowls are then cut through with needles till nothing remains externally connecting the anterior and posterior surfaces of the head, except the thin soft integument immediately behind the proboscis. The proboscis is then seized with forceps and a needle is placed on the last segment of the abdomen. A slow pull on the proboscis causes the glands to be withdrawn as before. This method has been found to fail so frequently however that it cannot be recommended as a working dissection. With several species of *Tabanus* this latter method of dissecting the salivary glands has been found to be invariably successful.

* E. A. Minchin, Proc. Roy. Soc., Ser. B., Vol. 76 ; Report on the Anatomy of the Tsetse-fly.

# A NEW SPECIES OF STYGEROMYIA (FAMILY MUSCIDAE, SUB-FAMILY STOMOXYDINAE) FROM THE EAST AFRICA PROTECTORATE.

By Ernest E. Austen.

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## Genus Stygeromyia, Austen.

The genus *Stygeromyia*, so far as is at present known, is confined to the Ethiopian Region. The species described below, of which the type is in the British Museum (Natural History), is the third to be discovered.

**Stygeromyia woosnami,** sp. n.

♂.—Length (1 specimen) 8 mm.; width of head 2·8 mm.; width of front at vertex between 0·5 and 0·6 mm.; length of wing 9 mm.; greatest width of wing 3·75 mm.

*Grey, with conspicuous clove-brown or dark brown markings on dorsum of abdomen, and with relatively large, hyaline wings. Distinguished from both* Stygeromyia maculosa, *Austen, and* S. sanguinaria, *Austen (the only species of this genus yet described), by its much larger size; further distinguished from* S. maculosa *by its more strongly marked thorax and very different abdominal markings, and from* S. sanguinaria *by the frontal stripe being much darker (clove-brown instead of walnut-brown) and distinctly wider below (instead of, as in ♂ of* S. sanguinaria, *of practically uniform width throughout), by the proboscis being clove-brown instead of orange-buff or ochraceous-buff, and by the femora being strongly suffused with dark grey instead of mainly buff or ochraceous-buff.*

*Head* light grey (occiput, except posterior orbits, dark grey), sides of face and spot above base of antennae shimmering yellowish silvery, all hair and bristles, like hair and bristles on rest of body and on legs, black; *frontal stripe* equal in width to the sides of the front (frontal margins or parafrontals) taken together; *palpi* ochraceous, bluntly rounded at tips, and beset with black bristles on outer side; first and second joints of antennae greyish cinnamon-rufous, third joint slate-grey (faintly orange-rufous on under side at base), terminal joint of arista clove-brown, with 11 hairs. *Thorax*: dorsum marked with five longitudinal stripes, of which the paired admedian stripes are the darkest, being clove-brown and very sharply defined and conspicuous when the insect is viewed at an obtuse angle from behind; in middle line is a mummy-brown and less sharply defined stripe, which commences a little way behind front margin, broadens out into a lanceolate shape after crossing transverse suture and terminates just in front of prescutellar groove; admedian stripes extend from front margin to a point on a level with middle of postalar calli; on each lateral half of dorsum, between admedian stripe and lateral margin, is a much broader dark brown stripe, which commences immediately behind humeral callus, is widely interrupted by transverse suture, and terminates slightly in front of level of anterior extremity of postalar

callus; in addition to the foregoing markings, the edges of the dorsum immediately behind the presutural depression on each side are suffused with a dark brownish tinge, there is a dark brown mark in the middle of each postalar callus, and the scutellum bears an ill-defined, mummy-brown, median, longitudinal stripe, in continuation of the median stripe on the main portion of the dorsum; pleurae and pectus unicolorous grey. *Abdomen*: dorsum of first three segments shimmering grey, with an undertint of isabella colour; dorsum of fourth segment grey, not shimmering and without an isabella-coloured undertint; dorsum of first three segments with a clove-brown, median, longitudinal stripe, which is broader on the second and third segments than on the first, and on the fourth segment is continued as a narrower, sepia-coloured stripe; extreme hind margin of first segment and hind borders of two following segments clove-brown, second and third segments also each with a large clove-brown blotch on each side of middle line, resting on hind border and extending forwards as far as or a little beyond middle of segment in each case; first segment also with a pair of similar but somewhat smaller and less sharply defined blotches; fourth segment with a large though fainter, sepia-coloured spot on each side of middle line, and not in contact either with middle line or with anterior, posterior, or lateral margin of segment; all abdominal markings more sharply defined when the insect is viewed at a low angle from behind; membrane clothing ventral surface buff-yellow, small median scutes grey. *Wings*: veins clove-brown; bend of fourth longitudinal vein somewhat less abrupt (the curve flatter and more gently rounded) than in the case of either *S. maculosa* or *S. sanguinaria*, and the bent up portion not perfectly straight but slightly curved upwards at the distal extremity. *Squamae* (thoracic pair) yellowish waxen-white, their borders cream-buff. *Halteres*: knobs cream-buff, stalks buff, darker at base. *Legs*: coxae and femora dark grey, the latter more or less ochraceous-buff at base and extreme tips; tibiae buff, more or less suffused with grey, middle and hind pair with a greyish dark brown blotch on proximal half; tarsi clove-brown.

East Africa Protectorate: plateau above Naivasha, alt. 7,500 ft., 1. i. 1911 (*R. B. Woosnam*).

The donor, in whose honour the author has much pleasure in naming this fine addition to the genus *Stygeromyia*, states that the specimen from which the above description has been drawn up was caught in bush at sunset, in the act of biting his arm.

# NOTES ON AFRICAN BLOOD-SUCKING MIDGES (FAMILY CHIRONOMIDAE, SUBFAMILY CERATOPOGONINAE), WITH DESCRIPTIONS OF NEW SPECIES.

By Ernest E. Austen.

Plate I.

*(Published by permission of the Trustees of the British Museum.)*

## Genus Culicoides, Latr.

**Culicoides grahamii,** Austen.

*Culicoides grahamii*, Austen, Ann. Mag. Nat. Hist., Ser. 8, Vol. iii, March, 1909, p. 280; 'Illustrations of African Blood-Sucking Flies,' p. 7, Pl. I, fig. 3 (1909).

*Culicoides habereri*, Becker, Jahreshefte des Vereins für vaterländ. Naturkunde in Württemberg, Jahrg., 1909, p. 289, Taf. viii, ix (1909).

The identity of *Culicoides habereri*, Becker, with *C. grahamii*, Austen, is conclusively established as the result of a comparison of the typical series of the former with the type and para-types of the latter, which are preserved in the British Museum (Natural History). For the opportunity of making this comparison and thus proving the synonymy given above, the present writer is indebted to Dr. Kurt Lampert, of the Königl. Naturaliensammlung, Stuttgart, where the original material of *C. habereri* is preserved; with the most obliging courtesy Dr. Lampert not only forwarded for comparison the typical series described by Becker, but also presented three para-types of *C. habereri* to our National Collection.

So far as may be judged from the few observations on African Blood-Sucking Midges at present recorded or otherwise available, *Culicoides grahamii* would appear to be the commonest, most widely distributed, and most troublesome of these minute but bloodthirsty insects yet described from Tropical Africa. Notes on the behaviour of the species in Ashanti, the Congo Free State, and Uganda were given by the author in his 'Illustrations of African Blood-Sucking Flies' (pp. 7–8). The specimens described by Becker as *Culicoides habereri* were taken by Dr. Haberer in February, 1908, during the dry season, in Southern Cameroon, on the Sanaga River, near Abunamballa (Nachtigalschnellen), and on the M'Bam River, which is a tributary of the former stream. The following is a translation of Dr. Haberer's remarks on the species, as quoted by Becker (*loc. cit.*):—"On the shore and on the sandbanks this tiny Dipteron is especially troublesome to bathers, since in biting it displays a partiality for the wet body, although in order to suck blood it will also creep under clothes. The bite is unusually painful, and produces to begin with a little red spot (petechia) on the skin. The midges which have sucked their fill swell up to an extraordinary degree, as do the Sand-flies (Simuliidae). In a few hours the bitten spot itches intensely, and is also considerably swollen; only after the lapse of three days does the inflammation begin to subside and the swelling to disappear. Since the

insects occur in large numbers they cause quite a considerable amount of annoyance, and the natives, who are more or less indifferent to the attacks of Tsetse-flies and Sand-flies, are particularly afraid of the bites of these blood-suckers, for which they have characteristic names signifying 'tormentors' or 'scourges.'"

The following are the localities, dates of capture, etc., of the specimens of this species received since the publication of 'Illustrations of African Blood-Sucking Flies'; the records in all cases refer to females, since no examples of the opposite sex have yet reached England.

SOUTHERN NIGERIA: Yaba, Lagos, May, 1909 (one specimen only), "caught in veranda of bungalow" (with examples of *Culicoides distinctipennis*, sp. n.—*see* below, and many specimens of the West African race of *C. milnei*, Austen—*Dr. W. M. Graham, W.A.M.S.*); Bende, 27.viii.1911 (*Dr. P. H. Macdonald, W.A.M.S.*:—in possession of the Entomological Research Committee).

ANGOLA: San Salvador, Portuguese Congo, January and May, 1909, "biting morning and evening" (*Dr. Mercier Gamble*).

UGANDA PROTECTORATE: Mpumu, Chagwe, July, 1910; shore of Lake Victoria, August, 1910 (*Captain A. D. Fraser, R.A.M.C.*).

### Culicoides brucei, Austen.

*Culicoides brucei*, Austen, Ann. Mag. Nat. Hist., Ser. 8, Vol. iii, March 1909, p. 282; 'Illustrations of African Blood-Sucking Flies,' p. 6, Pl. I, fig. 2 (1909).

In this species the wing-markings may be described as consisting of dark spots, blotches, and streaks upon a light ground, being therefore markedly different in character from those exhibited by, at any rate, *C. milnei* and the first two of the new species described below, in all of which the ground-colour of the wings is dark while the spots are light. *Culicoides brucei* is still known only from the Uganda Protectorate, where (in the vicinity of the Mianga River) the type and para-types were obtained in July, 1903. It is to be hoped that collectors will keep a special look-out for this easily recognisable midge, which, like its congeners, is doubtless common enough in places where it occurs.

### Culicoides milnei, Austen.

*Culicoides milnei*, Austen, Ann. Mag. Nat. Hist. Ser. 8, Vol. iii, March 1909, p. 283; 'Illustrations of African Blood-Sucking Flies,' p. 6, Pl. I, fig. 1 (1909).

This species, which was originally received from the East Africa Protectorate, and was subsequently ('Illustrations of African Blood-Sucking Flies,' *loc. cit.*) recorded by the author as occurring in Uganda, is also found in the Anglo-Egyptian Sudan and in Southern Nigeria, where it is apparently represented by a local race, which differs from the typical form in being considerably smaller, and in having the two distal light costal spots on the wings much closer together. Specimens of *C. milnei*, which may be regarded as being intermediate between the typical form and the West African or Southern Nigerian race, have been captured in the Uganda Protectorate by Drs. McConnell and Duke. The

following particulars with reference to recently collected examples of the species under consideration are supplementary to previously published records :—

UGANDA PROTECTORATE : Mpumu, Chagwe, May, 1911 (*Dr. H. L. Duke*); Okellobong's, Lango, Nile Province, 21. vi. 1911, 5.45 a.m.; Nabiesu, 26. vi. 1911 ; Kaduku, 29. vi. 1911, 6 a.m. (*Dr. R. E. McConnell*—in possession of the Entomological Research Committee).

ANGLO-EGYPTIAN SUDAN : Malek, near Bor, R. Nile, 10. x. 1909 (Rev. — Shore).—The three examples collected by Mr. Shore are somewhat smaller than the typical form, with which, however, they agree fairly closely in other respects. They were submited for examination by Mr. H. H. King, of the Wellcome Research Laboratories, Khartoum, through whose courtesy one of the specimens has been added to the National Collection.

SOUTHERN NIGERIA : Yaba, Lagos, 11 and 12, iv., and 20. v. 1909, "caught in veranda of bungalow, 9.0 and 10.0 p.m." (*Dr. W. M. Graham, W.A.M.S.*).

Among the large number of specimens of the local race taken by Dr. Graham in his veranda at Yaba, is the first male of *Culicoides milnei* yet received. In this specimen the long hairs clothing the antennae are shining ochre-yellow, while the light spots on the wings, with the exception of those on the costal margin, are apparently somewhat fainter than in the female.

**Culicoides distinctipennis**, sp. n. (Pl. I, fig. 1).

♀.—Length (6 specimens) 0·8 to 1 mm. ; length of wing 1 to 1·2 mm.

*Allied to* C. milnei, *Austen, but distinguishable at once owing to its much smaller size, and to conspicuous differences in the wing-markings.—Dorsum of thorax* (*in dried specimens*) *dark brown, mummy-brown,* or russet-brown, longitudinally striped and marked with drab-grey ; dorsum of abdomen* (*in dried specimens*) *clove-brown ; wings mouse-grey* (*strongly iridescent when the light falls on them at a certain angle*), *conspicuously marked with a series of creamy-white spots, the shape, position, and arrangement of which is shown in* fig. 1 ; *knees conspicuously infuscated.*

*Head* : vertex sparsely clothed with long, curved, blackish hairs ; *palpi* sepia-coloured, clothed with brownish hairs, third joint darker than the two following joints ; *antennae* clothed with brownish or yellowish hairs, first two or first three joints sepia-coloured, remaining joints isabella-coloured. *Thorax* : dorsum sparsely clothed with erect, yellowish or brownish hairs, and (in well-preserved specimens) exhibiting anteriorly a median, elongate, greyish pollinose, *lyrate* mark, each anterior extremity of which runs outwards to the corresponding humeral callus ; from about the middle of the dorsum, where the two halves of the lyrate mark meet together, the lyrate mark is connected with the hind margin by a broad, median, greyish pollinose stripe, enclosing a pair of elongate dark brown spots, one of which is situate on each side of the middle line ; on hind margin of main portion of dorsum the greyish pollinose area sends out a prolongation on each side, which includes each posterior angle and then curves forwards to form a grey, elongate blotch above base of each wing ; anteriorly on each side of dorsum, and posteriorly to the swelling behind the corresponding humeral callus, an

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* For names and illustrations of colours *see* Ridgway, "A Nomenclature of Colors for Naturalists" (Boston : Little, Brown, and Company, 1886).

ill-defined greyish pollinose mark runs obliquely outwards to the lateral margin; *scutellum* grey on each side; pleurae drab-grey. *Abdomen*: dorsum sparsely clothed with yellowish hairs, lateral and posterior borders of segments except last smoke-grey. *Wings*: surface beyond anterior transverse vein and also that posterior to fourth longitudinal vein clothed with minute hairs (conspicuous under a low-powered compound microscope), which are dark on the grey areas and, at least in part, pale (glistening yellowish or cream-buff) on the light spots; third longitudinal vein connected with first longitudinal for a short distance before latter turns to meet costa; veins or portions of veins included within or in contact with pale spots cream-buff: as regards the pale spots, the chief distinctive characters of *C. distinctipennis* as compared with *C. milnei*, Austen,* are—the presence of a spot (entirely wanting in the wing of *C. milnei*) immediately in front of the bifurcation of the fourth longitudinal vein; the situation of the distal costal spot close to the tip of the wing and just in front of the end of the anterior branch of the fourth longitudinal vein, instead of approximately midway between the end of this branch and the middle costal spot; the position of the distal of the two spots enclosed between the branches of the fourth longitudinal vein, this spot practically resting on the wing-margin instead of being conspicuously further from the latter than are the two following marginal spots; and lastly, the relative position of the two spots on the proximal side of the posterior branch of the fifth longitudinal vein, which are one above the other, whereas in *C. milnei* the spot further from the hind margin is much nearer the base of the wing. *Halteres* isabella-coloured, base or proximal half or two-thirds of knobs clove-brown or dark brown. *Legs* isabella-coloured, femora each with a narrow pale band just before the tip, tibiae with a similar band just beyond the base.

SOUTHERN NIGERIA; UGANDA PROTECTORATE: type and other specimens (para-types) from Yaba, Lagos, "taken in veranda of bungalow" (with many specimens of the West African race of *Culicoides milnei*, Austen, and one specimen of *C. grahamii*, Austen), May, 1909 (*Dr. W. M. Graham, W.A.M.S.*); an additional para-type from donor's bungalow at same place, "caught near lamp, 9.0 p.m.," 18. v. 1909 (*Dr. W. M. Graham, W.A.M.S.*); three specimens from Kibanga, Chagwe, Uganda Protectorate, August, 1910 (*Captain A. D. Fraser, R.A.M.C.*).

All the above-mentioned specimens of *Culicoides distinctipennis*, as also the types of the other new species described in this paper, are in the British Museum (Natural History).

### **Culicoides neavei**, sp. n. (Pl. I, fig. 2).

♀.—Length (1 specimen) 1·2 mm.; length of wing 1·25 mm.

*Allied to and resembling the foregoing species, from which, however, it is readily distinguishable owing to certain differences in the wing-markings,—notably the smaller size of the creamy-white spots (other than the costal spot at each end of the third longitudinal vein), and the absence of a spot in front of the bifurcation of the fourth longitudinal vein* (cp. figs. 1 and 2).

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* Compare fig. 1 and the coloured figure of *C. milnei* in the author's 'Illustrations of African Blood-Sucking Flies,' Plate I, fig. 1 (1909).

*Head* darkish grey, sparsely clothed on vertical region with curving, yellowish hairs; *palpi* dark sepia-coloured, clothed with brownish hair, distal extremity of terminal joint clothed with yellowish hairs; *antennae* clothed with yellowish hair, first and second joints sepia-coloured, remaining joints isabella-coloured. *Thorax:* dorsum drab-grey, with dark mummy-brown markings, consisting of a narrow median stripe (somewhat broader in front and behind but obliterated or nearly so in centre of dorsum), and some spots on each side of median stripe, between it and lateral margin; a little way in front of presutural furrow is a small elliptical ovate spot on each side of median stripe; in front and a little to the outside of each of these spots is a larger cuneiform mark; lateral margin of dorsum immediately above dorsopleural suture is also dark brown (at least when viewed in a certain direction), and between this and a (more or less ill-defined) backwardly directed prolongation of each cuneiform mark there is a small brown spot; dorsum sparsely clothed with yellowish hair; scutellum cream-buff, with a dark brown median stripe; metanotum clove-brown, with a pair of rounded, drab-grey spots on upper margin. *Abdomen:* dorsum mummy-brown, distal extremity darker. *Wings* mouse-grey (with a beautiful purplish iridescence when light falls on them at a certain angle), marked with creamy-white spots, as shown in fig. 2; spot in front of distal extremity of anterior branch of fourth longitudinal vein very small and rounded; spots enclosed within fork of fourth longitudinal vein, as also those in front of anterior branch of same vein much further apart than corresponding spots on wing of foregoing species; other differences as compared with *Culicoides distinctipennis*—besides those mentioned in diagnosis—are the greater obliquity of the anterior transverse vein, the greater length of the rami of the fourth longitudinal vein, which bifurcates nearer the base of the wing, and the different shape of the interspace between the distal portions of the first and third longitudinal veins (the two stout veins next the costa beyond the level of the anterior transverse vein)—cp. figs. 1 and 2; first and third longitudinal veins connected together for a short distance about the middle of their length; hairiness as in foregoing species. *Halteres* cream-buff or light isabella-coloured, knobs and stalks light sepia-coloured at base. *Legs* isabella-coloured, middle and hind tibiae and distal portions of middle and hind femora darker (brownish drab); knees and tips of tibiae (at least those of middle and hind pairs) infuscated (sepia-coloured); tibiae each with a narrow pale band just beyond base, and (at least in case of middle and hind pairs) with a similar band just before the tip.

UGANDA PROTECTORATE; BAHR-EL-GHAZAL PROVINCE, ANGLO-EGYPTIAN SUDAN. Type from vicinity of Kumi, Umiro, Uganda Protectorate, 3,700 ft., 16–18. viii. 1911 (*S. A. Neave:* presented by the Entomological Research Committee).

Since the foregoing description was drawn up, three specimens of this species from M'Volo, Bahr-el-Ghazal Province, Anglo-Egyptian Sudan, 15. i. 1911 (*H. H. King*), have been received for examination from the Entomological Research Committee, by whom one specimen has been presented to the National Collection. These midges, which agree quite well with the typical example of *C. neavei*, bear the following field-note by Mr. King:—"Biting man; bloodthirsty at dawn."

**Culicoides kingi,** sp. n. (Pl. I, fig. 3).

♀.—Length (7 specimens) just under 1 mm. to 1·25 mm.; length of wing 1 to 1·2 mm.

*Upper portion of head and dorsum of thorax olive-grey, latter with sepia-coloured or dark brown markings; abdomen in dried specimens which apparently had not fed prior to being killed dirty waxen-white (except at posterior extremity, which is infuscated);* abdomen in dried specimens which appear to have sucked blood before being killed, isabella-coloured, sepia-coloured or clove-brown, paler at base or in some specimens with an ill-defined paler area on proximal half, not extending to sides; wings with conspicuous markings, as shown in fig.* 3 ; *legs cream-buff or pale isabella-coloured, with darker markings, knees dark brown, sharply defined and conspicuous.*

*Head:* vertex and upper part of occiput sparsely clothed with pale hairs; *eyes* narrowly separated; *palpi* and *proboscis* light mummy-brown; first and second joints of *antennae* mummy-brown, remaining joints isabella-coloured, clothed with pale hair. *Thorax:* markings on dorsum consisting of a pair of narrow, admedian, longitudinal stripes, extending from front margin half-way to pre-sutural groove or slightly further, and divergent at the tips; between each admedian stripe and lateral margin is a curved, claw-like mark behind and on the inner side of the humeral region, and behind this a somewhat similar backwardly directed mark; tip of scutellum sometimes dark brown; pleurae and pectus grey. *Wings* smoke-grey, with pale (cream-coloured or hyaline) spots and blotches, as shown in fig. 3; resting on costa are two dark blotches, which are darker than remaining portions of grey area; one of these, situated approximately in middle of costal border, occupies the space between the distal extremities of the first and third longitudinal veins and the costa, the other lies beyond it, at the commencement of the distal third of the costal border; when the wing is viewed against a dark background these two blotches appear to be of approximately the same tint, and but little darker than either of the other two grey blotches resting on the costa; when, however, the wing is examined against a light background, such as a sheet of white paper, the blotch between the distal extremities of the first and third longitudinal veins and the costa appears much darker than any other; extreme base of wing and anterior portions of light spots resting on costa more or less cream-coloured, remaining light spots and blotches hyaline or nearly so; third longitudinal vein not connected by a cross-vein with first longitudinal, but appearing to be completely fused with the latter when wing is merely examined under a hand-lens or low-powered compound microscope; under higher magnification and *by transmitted light*, third longitudinal vein is seen to be separated from, though closely adjacent to, first longitudinal, from its origin to point at which it turns towards costa, where it becomes indistinct; fork of fourth longitudinal vein narrower and also longer than in case of *Culicoides distinctipennis*, the *bifurcation* taking place *before* instead of beyond *the middle of the wing*; surface of the wing much less hairy than in *C. distinctipennis*, the larger hairs on the surface, which are visible under a low-powered compound microscope,

* In one of the para-types the abdomen, in addition to being dirty waxen-white except at the posterior extremity, is distended and sac-like; another para-type shows the same peculiarity, though to a lesser degree.

being most numerous between the anterior branch of the fourth longitudinal vein and the costa; the branches of the fourth and fifth longitudinal veins each bear a single row of hairs, as do the wing-folds between the rami of the fourth vein and between the posterior branch of the latter and the anterior branch of the fifth longitudinal; the greater part of the proximal portion of the first longitudinal vein bears hairs at intervals in a single row, and the fold in front of the anterior branch of the fourth longitudinal vein, and a portion of the vestige of the seventh longitudinal are also beset with hairs in a single series; scattered hairs are present in the vicinity of the hind margin of the wing, from the anterior branch of the fourth longitudinal vein to about the middle of the anal lobe, and there are also hairs in a single row on the fifth vein just before its bifurcation; cross-vein near base of wing blackish, anterior transverse vein and portions of longitudinal veins between it and costa cream-buff; anterior transverse vein much more oblique, and first basal cell (the cell on the proximal side of the anterior transverse vein) much narrower than in *C. distinctipennis*. *Halteres* cream-coloured. *Legs:* femora infuscated (brownish) on distal third, but with a narrow pale band immediately before the dark brown tip; base of tibiae marked with a narrow pale band (extreme base dark brown), front and middle tibiae beyond basal pale band brownish or brown nearly to the tips, hind tibiae in fully coloured specimens with a more sharply defined brownish or dark brown band on basal half, beyond basal pale band; extreme tips of hind tibiae clove-brown.

ANGLO-EGYPTIAN SUDAN: type and six para-types from Khor Arbat, Red Sea Hills, 8, 9. ix. 1909 (*H. H. King*).

So far as it is possible to judge from the description and figure of *Culicoides* (*Ceratopogon*) *schultzei*, Enderlein,* *C. kingi*, which the present author has much pleasure in naming in honour of its discoverer, is more closely related to this species than to any other yet described. *Culicoides schultzei*, however, of which the typical specimens (♂ and ♀) were taken in German South-West Africa (Hinterland of Walfisch Bay), in May, 1905, while apparently agreeing with *C. kingi* in the essential features of its venation, would seem to differ from it in the head, thorax, and legs being darker, and in the hyaline spots and blotches on the wings being less extensive and somewhat different in shape.

### Genus JOHANNSENIELLA, Will.

**Johannseniella fulvithorax**, sp. n.

♀.—Length (2 specimens) 1·25 mm.; length of wing 1·4 mm.

*Dorsum of thorax ochraceous-buff, without markings; abdomen brownish; wings light drab-grey* (iridescent when light falls on them at certain angles), *with two large and conspicuous cream-coloured spots on costal border, one spot covering anterior transverse and base of third longitudinal veins, and extending from costa to just beyond*

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* Zoologische und Anthropologische Ergebnisse einer Forschungsreise im Westlichen und Zentralen Südafrika, ausgeführt in den Jahren 1903–1905 . . . . von Dr. Leonhard Schultze. Erster Band: zweite Lieferung. P. 459, Taf. xix, fig. 2 (Jena: Verlag von Gustav Fischer. 1908).

*fourth longitudinal vein, the other spot also resting on costa and covering distal extremity of third longitudinal vein, but not reaching anterior branch of fourth longitudinal vein.*

*Head* dark mouse-grey above, sparsely clothed with brownish hair; *palpi* and *antennae* isabella-coloured, sixth and following joints of antennae more or less cylindrical; *proboscis* dark brown. *Thorax:* metanotum mummy-brown or sepia-coloured. *Wings:* first and third longitudinal veins connected together for a short distance just before former turns towards costa, dark brown except portions included in the cream-coloured spots; fourth longitudinal vein bifurcating a little beyond middle of wing; on hind border a trace of an ill-defined pale spot sometimes distinguishable between the rami of the fifth longitudinal vein; distal extremity of wing sparsely clothed with minute hairs, which are most numerous next costa, beyond distal extremity of third longitudinal vein; there are also two longitudinal rows of similar hairs between distal extremities of the rami of the fourth vein, and another and longer row in front of the anterior ramus of this vein, while the distal extremities of the rami of the same vein each bear a few hairs arranged in a single row. *Legs* pale isabella-coloured, femora brownish, with a pale band before the tips; knees sepia-coloured; extreme tips of hind tibiae brownish.

East Africa Protectorate: type and one other specimen (para-type) from the Yala River, on the southern edge of the Kakumega Forest, 4,800–5,300 ft., 21–28. v. 1911 (*S. A. Neave:* presented by the Entomological Research Committee). The following note by Mr. Neave is attached to the type:—“Biting my hand at light, 7.30 p.m.”

This is the first species of *Johannseniella* to be described from the Ethiopian Region.

### Genus Ceratopogon (Subgenus Forcipomyia (Mg.), Kieffer), Mg.

**Ceratopogon castaneus,** Walk.

*Ceratopogon castaneus*, Walker, List. Dipt. Ins. in coll. Brit. Mus., Part I, p. 26 (1848).

An examination of the type and para-type of *C. castaneus*—obtained in Sierra Leone (*Rev. D. F. Morgan*) and presented to the British Museum so long ago as 1838—shows that while the generic position was quite correctly determined by the describer, the species belongs to the subgenus *Forcipomyia*, as characterised by Kieffer (Wytsman's ‘Genera Insectorum,’ Diptera, Fam. Chironomidae, p. 49 (1906)).

In April, May, and July, 1909, females of this species were collected at Yaba, Lagos, Southern Nigeria, by Dr. W. M. Graham, W.A.M.S., by whom they were subsequently presented to the National Collection. A study of this material renders it possible to supplement Walker's extremely brief description as follows:—

♀.—Length (5 specimens) 1·4 to 1·6 mm., length of wing 1·2 to 1·4 mm.

*Head*, dorsum of *thorax* (including metanotum), and dorsum of *abdomen* dark sepia-brown; vertical region of head, dorsum of thorax (except metanotum), and dorsum of abdomen clothed with dark brown or blackish hair, mixed on thorax

and abdomen with minute, glistening ochraceous hairs ; *scutellum* fringed with long, dark brown hairs ; pleurae and pectus buff or cream-buff, ventral surface of abdomen (when not darkened by the presence of food in the alimentary canal) similarly coloured, though ventral scutes of third and three following abdominal segments with a small brown fleck on each side. *Wings* densely clothed with dark brown hairs, which are darker on anterior margin than elsewhere ; extreme base of wings, and *a small but conspicuous spot about middle of anterior margin cream-buff. Legs* pale yellow, clothed with similarly coloured hairs ; *hind femora with a narrow but conspicuous sepia-coloured band at about two-thirds of their length from the base;* tarsal joints somewhat infuscated, at least in part ; first joint of hind tarsi about one-third shorter than following joint.

The dates on which Dr. Graham's specimens were captured are—11.iv.1909, 14.iv.1909 (two examples), 23.v.1909, and 14.vii.1909 : the specimen taken on May 23rd was caught in the donor's bedroom at 9.0 p.m., all the others were collected in the veranda of his bungalow at the same hour.

So far as the present writer is aware, no species belonging to the genus *Ceratopogon* as restricted by Kieffer (*i.e.*, consisting solely of the species comprised in the subgenera *Atrichopogon*, *Ceratopogon*, and *Forcipomyia*) is definitely known to suck the blood of Vertebrates. It is therefore interesting to note that in the case of the type-specimen both of *C. castaneus*, and of the larger of the two new species described below, the abdomen, judging at least from an external examination, is distended apparently by coagulated blood.

### **Ceratopogon incomptifeminibus**, sp. n.

♀.—Length (two specimens), 1·4 mm. ; length of wing, 1 mm.

*Presenting a close superficial resemblance to the foregoing species, but distinguishable by the hind femora being without a sepia-coloured band.*

*Head* dark brown, clothed with dark brown or brownish hair ; *palpi* and *proboscis* mummy-brown ; *antennae* light mummy-brown, last five joints clothed with pale yellowish hairs, verticillate hairs dark brown. *Thorax :* dorsum dark sepia-brown, clothed with ochraceous hair ; pleurae and pectus cream-buff, streaked with mouse-grey ; metanotum clove-brown. *Abdomen :* dorsum dark mummy-brown (extreme base and penultimate segment paler), clothed with yellowish hair ; venter mainly cream-buff. *Wings* as described above in case of foregoing species. *Halteres* cream-buff, base of knobs slightly darker. *Legs* pale yellow, clothed with similarly coloured hairs ; *hind femora without a sharply defined sepia-coloured band* at about two-thirds of their length from the base, but with their distal extremities mummy-brown on upper surface ; first joint of hind tarsi slightly (about one-fourth) shorter than following joint.

ASHANTI : Obuasi, 23.iv.1906 (*Dr. W. M. Graham, W.A.M.S.*).

### **Ceratopogon inornatipennis**, sp. n.

♀.—Length (one specimen), 2 mm. ; length of wing, 1·6 mm.

*Distinguished from the two preceding species by its much larger size, by the costal margin of the wings being entirely devoid of a light spot, and by the much greater length of the second joint of the hind tarsi, which is about twice as long as the first joint.—Dorsum of thorax olive, clothed with bright, Naples-yellow hairs ; dorsum of*

*abdomen seal-brown, clothed with seal-brown hairs; legs and their hairy covering pale ochre-yellow, front tarsi, tips of hind tarsi, and first joint and tips of three following joints of middle tarsi somewhat infuscated, at least when viewed from certain directions.*

*Head* dark olive-brown, clothed on vertex with yellowish hairs, and elsewhere above with clove-brown or blackish hairs; *palpi* and *proboscis* clove-brown, former clothed with similarly coloured hair; *antennae* clothed partly with yellowish partly with blackish hairs, verticillate hairs blackish, first two joints of antennae sepia-coloured or dark mummy-brown, next eight joints paler (light raw-umber-coloured), last five joints mummy-brown. *Thorax:* metanotum clove-brown; pleurae and pectus dark sepia-coloured, upper margin of former cream-coloured. *Abdomen:* hind margins of dorsal scutes of second to sixth segments inclusive sparsely fringed with short, pale yellow hairs; lateral margins of same segments and entire ventral surface (except perhaps at base) thickly clothed with bright Naples-yellow hairs. *Wings* strongly iridescent, thickly clothed with dark brown hairs; portion of costa from near base of wing to end of third longitudinal vein, as well as latter vein itself and terminal portion of first longitudinal sepia-coloured, darker than remaining veins or portions of veins, and clothed with longer and darker hair than is elsewhere present on the wings, so that under a hand-lens this portion of the costa has a thickened appearance. *Halteres* primrose-yellow.

SOUTHERN NIGERIA: Yaba, Lagos, 28.vi.1909, "caught in veranda of bungalow, 10.0 p.m." (*Dr. W. M. Graham, W.A.M.S.*)

The abdomen of the type of this species is distended beneath, perhaps with blood.

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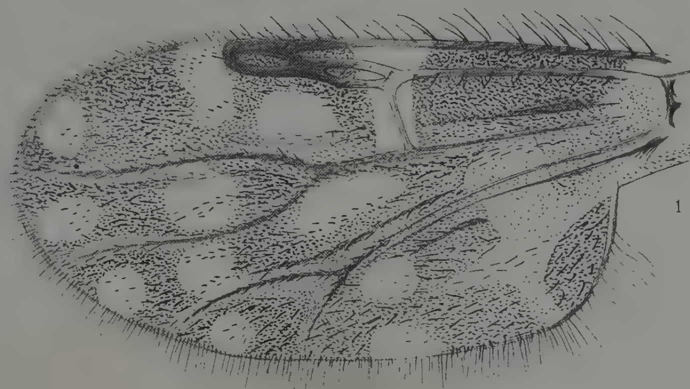
## EXPLANATION OF PLATE I.

Fig. 1.—Wing of *Culicoides distinctipennis*, Austen. x 85.
2. " " " *neavei*, " x 80.
3. " " " *kingi*, " x about 90.



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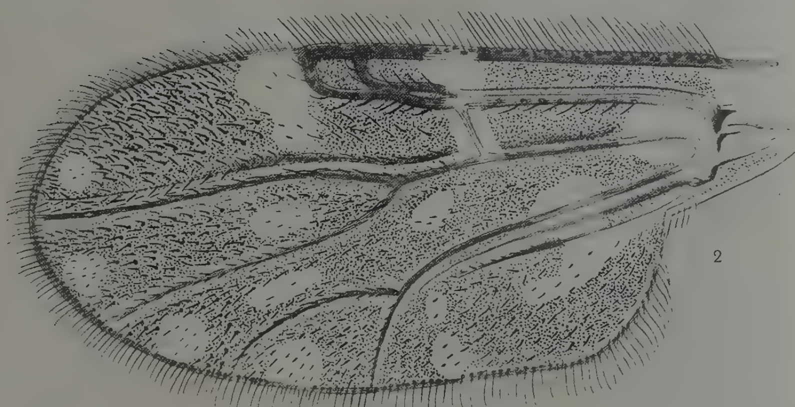

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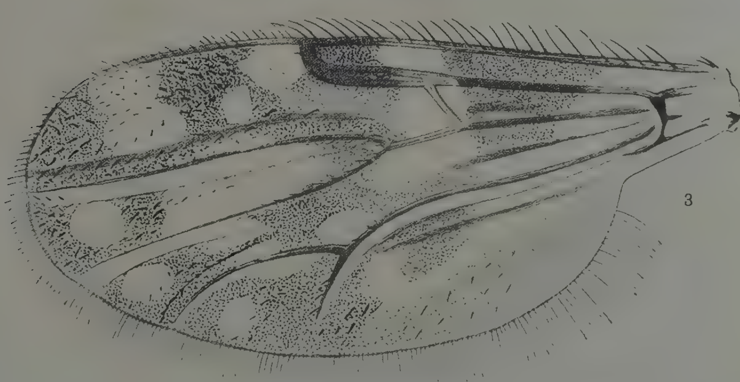

3

E. E. Austen ad nat. del. Bale & Danielsson, Ltd., photo-sculps.

WINGS OF NEW SPECIES OF AFRICAN CULICOIDES.

## COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st October and 31st December, 1911) :—

Dr. W. M. Aders :—2 *Culex tigripes*, 12 Lepidoptera (various stages), 15 Hymenoptera, 12 Coleoptera, and 12 Rhynchota ; from Zanzibar.

Capt. A. H. Blair :—4 *Tabanus*, 1 *Chrysops*, 8 *Glossina*, and 1 other Dipteron ; from Ilesha, Southern Nigeria.

Mr. E. Brand :—3 Mosquitos and 1 *Haematopota* ; from Malindi, British East Africa.

Dr. C. L. Chevalier :—3 *Glossina* ; from Kismayu, British East Africa.

Dr. Andrew Connal :—241 Culicidae, 8 Tabanidae, 1 *Glossina palpalis*, 11 *Lyperosia*, 4 *Stomoxys*, 3 *Cordylobia*, and 10 other Diptera ; from the Gold Coast.

Dr. Robert Drummond :—18 Tabanidae, 9 *Auchmeromyia*, 93 other Diptera, 21 Hymenoptera, 2 Lepidoptera, and 2 Arachnida ; from Zomba, Nyasaland.

Mr. G. W. Evans :—11 Mycetophilidae and a number of Aphids ; from Nairobi, British East Africa.

Mr. T. E. Fell :—7 Culicidae, 5 *Hippocentrum*, 27 *Glossina*, 4 other Diptera, 2 Hymenoptera, and 2 Coleoptera ; from the Western Province of Ashanti.

Dr. J. L. Gilks :—10 *Glossina* ; from Lamu, British East Africa.

Dr. J. H. Goodliffe :—6 *Haematopota* ; from Ankole, Uganda.

Mr. A. R. Gould :—6 Culicidae, 1 *Glossina*, 1 other Dipteron, 3 Lepidopterous larvae, 1 Hymenopteron, 10 Coleoptera, 12 Thrips, 2 Orthoptera, 2 Rhynchota, 8 Reptiles, and 3 Fungi ; from Aburi, Gold Coast.

Mr. C. C. Gowdey :—2 Culicidae, 11 *Tabanus*, 1 *Chrysops*, 9 *Haematopota*, 4 Hippoboscidae, 441 other Diptera, 2,384 Lepidoptera, 633 Hymenoptera, 1,187 Coleoptera, 2 Planipennia, 1,041 Orthoptera, 19 Odonata, 78 Thrips, 15 Coccidae, and 932 other Rhynchota ; from Uganda.

Dr. J. A. Haran :—4 Culicidae ; from Nairobi, British East Africa.

Dr. R. C. Hiscock :—16 *Tabanus*, 2 Lepidoptera, 1 Coleopteron, and 1 Cicada ; from Oshogbo, Southern Nigeria.

Dr. A. P. D. Hodges, P. M. O. :—1 Culicid, 1 *Tabanus*, 1 Hymenopteron, and 1 Arachnid ; from Entebbe, Uganda.

Capt. L. E. H. Humfrey :—7 Culicidae, 4 *Chrysops*, 125 *Tabanus*, 70 *Glossina*, and 5 other Diptera ; from Southern Nigeria.

Mr. E. Hutchins :—1 Hippoboscid, 253 Anoplura, and 506 Ticks ; from Entebbe, Uganda.

Dr. R. E. McConnell :—12 Culicidae, 5 *Culicoides*, 6 *Simulium*, 15 *Tabanus*, 5 *Haematopota*, 113 *Glossina* (and 4 slides of ♂ genital armature), 1 *Stomoxys*, 3 *Lyperosia*, 1 *Auchmeromyia*, 1 larva of *Cordylobia*, 8 other Diptera, 1 Flea, 1 Psychid larva and case, 3 Hymenoptera, 5 Rhynchota, 119 Ticks, and 1 Worm ; from Uganda.

Dr. C. H. Marshall :—1 Culicid, 1 *Haematopota*, 1 other Dipteron, 1 Hymenopteron, 47 Coleoptera, 13 Rhynchota, and 1 Orthopteron ; from Lake Matanda, Uganda.

Dr. T. F. G. Mayer :—4 Culicidae, 6 *Haematopota*, 3 *Hippocentrum*, 2 *Stomoxys*, 5 other Diptera, and 1 Hymenopteron ; from Oshogbo, Southern Nigeria.

Dr. Wm. Morrison :—9 Culicidae, 41 *Tabanus*, 19 *Haematopota*, 9 *Hippocentrum*, 7 *Glossina*, 5 *Stomoxys*, 29 *Hippobosca maculata*, 2 other Diptera, 5 Hymenoptera, 6 Coleoptera, 6 Rhynchota, 9 Odonata, 4 Orthoptera, 15 Trombidiidae, and 2 spiders ; from Northern Nigeria.

Dr. A. Mouat :—12 Fleas ; from Kisumu Township, British East Africa.

Mr. S. A. Neave :—48 Culicidae, 67 *Chrysops*, 762 *Haematopota*, 700 *Tabanus*, 78 *Glossina*, 1 *Auchmeromyia*, 1 Hippoboscid, 216 other Diptera, 6,583 Lepidoptera, 18 Hymenoptera, 6 Rhynchota, 12 Orthoptera, 4 Odonata, and 3 Neuroptera ; from Uganda.

Dr. Lucius Nicholls :—176 Diptera, 4 Hymenoptera, and 5 other insects ; from St. Lucia, British West Indies.

Mr. T. Preston :—6 Culicidae ; from Nairobi, British East Africa.

Dr. J. Pugh :—6 *Tabanus*, 47 *Haematopota*, 1 *Chrysops*, 19 *Glossina*, 1 *Stomoxys*, 70 other Diptera, and 1 Hymenopteron ; from the Kanyamkago District, British East Africa.

Dr. W. L. Radford :—10 Culicidae, 2 *Glossina*, 5 other Diptera, 2 Fleas, and 5 Ticks ; from Malindi District : and numerous Bed-bugs ; from Mombasa, British East Africa.

The Royal Society's Sleeping Sickness Commission (collected by Dr. G. D. H. Carpenter) :—1 Mosquito, 4 *Tabanus*, 1 *Haematopota*, 72 *Glossina*, 1 Hippoboscid, 44 other Diptera, 224 Hymenoptera, 48 Coleoptera, 2 Termites, 11 Orthoptera, 1 Dragonfly, a number of Aphids, 10 other Rhynchota, 40 Mallophaga, 4 Ticks, a number of Mites, 4 other Arachnida, 1 Millipede, and 1 Worm ; from Uganda.

Lieut. A. C. Saunders, 3rd K. A. Rifles :—5 *Tabanus* and 1 *Hippobosca* ; from Lake Rudolf, British East Africa.

Dr. G. Strathairn :—67 Culicidae, 1 *Haematopota*, 1 other Dipteron, and 1 Millipede ; from Entebbe, Uganda.

Mr. C. F. M. Swynnerton :—4 Culicidae, 57 *Diatomineura* sp. nov., 9 *Cadicera*, 168 *Haematopota sanguinaria*, 19 *Tabanus*, 503 other Diptera, 13 dipterous pupa-cases, 57 Hymenoptera, 1 Coleopteron, 2 Orthoptera, 10 Rhynchota, and 1 Arachnid ; from Southern Rhodesia.

Mr. R. P. Thomas :—139 Ticks ; from Mombasa, British East Africa.

Dr. R. van Someren :—2 *Tabanus*, 4 Coleoptera, 2 Hymenoptera, and 1 Orthopteron ; from the Nile Province of Uganda.

Mr. F. C. Willcocks: 4 Tabanidae, 12 Cecidomyidae, 197 other Diptera, 45 Lepidoptera, 96 Coleoptera, 58 Chalcididae and Braconidae, 136 other Hymenoptera, 9 Planipennia, 98 Thrips, and 82 Rhynchota ; from Cairo, Egypt.

# NEW AFRICAN TABANIDAE.—PART I.

By Ernest E. Austen.

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The following paper contains descriptions of eleven new species belonging to seven genera, besides notes on some other species. The types of all the new forms are in the British Museum (Natural History). As indicating the countries in which the new species have been obtained, the appended list may be of service.

## *PANGONIINAE.*

### Genus Silvius, Mg.

*Silvius fallax*, sp. n. ... ... ... Northern Rhodesia.

### Genus Cadicera, Macq.

*Cadicera distanti*, sp. n. ... ... ... Transvaal.
„ *speciosa*, sp. n. ... ... German East Africa.
„ *flavicoma*, sp. n. ... ... Nyasaland Protectorate.

### Genus Pangonia, Latr.

*Pangonia comata*, sp. n.... ... ... East Africa Protectorate.

### Genus Dorcaloemus, Austen.

*Dorcaloemus silverlocki*, sp. n. ... ... Northern Rhodesia.

### Genus Subpangonia, Surcouf.

*Subpangonia grahami*, sp. n. ... ... Ashanti ; Southern Nigeria.

## *TABANINAE.*

### Genus Tabanus, L.

*Tabanus canofasciatus*, sp. n. ... ... East Africa Protectorate.
„ *tenuipalpis*, sp. n. ... ... Gold Coast (including Ashanti).
„ *barclayi*, sp. n. ... ... Nyasaland Protectorate.

### Genus Hippocentrum, Austen.

*Hippocentrum murphyi*, sp. n. ... ... Sierra Leone Protectorate.

## *PANGONIINAE.*

### Genus Silvius, Mg.

**Silvius fallax**, sp. n. (fig. 1.)

♂ ♀.—Length, ♂ (15 specimens) 10·25 to 12·25 mm., ♀ (16 specimens) 10 to 11·75 mm. ; width of head, ♂ 4 to 4·5 mm., ♀ 3·6 to 4·2 mm.; width of front of ♀, at vertex 0·6 to 0·75 mm., across lower edge of frontal callus 1 to 1·2 mm.; length of wing, ♂ 9·6 to 11 mm., ♀ 9·25 to 10·6 mm.

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*Looking like a small* Tabanus, *and in general appearance, and especially in its abdominal markings, presenting a deceptive resemblance to* Silvius decipiens, *Lw.*, *from which it differs in the general ground-colour of the dorsum of the abdomen, in the wings being without a dark and sharply defined stigma, and, in the female sex, in the eyes being less distinctly hairy, in the front being longer, and in the frontal callus not extending to the eyes.—Eyes densely hairy in ♂, microscopically hairy (under an ordinary hand-lens often appearing bare) in ♀; dorsum of thorax slate-black* in ♂, slate-coloured, dark brown, dark chestnut-brown, or reddish-brown in ♀, with grey longitudinal stripes (shorter and less conspicuous in ♂) in both sexes; dorsum of abdomen cinnamon-rufous or dark chestnut-brown (in ♂ with a broad, black median longitudinal stripe on second to fourth segments inclusive, and distal extremity clove-brown), with a double series of rounded or transversely elongate spots (especially large and conspicuous in ♀), hind borders of segments, and a median series of triangles resting on latter smoke-grey or drab-grey; wings hyaline.*

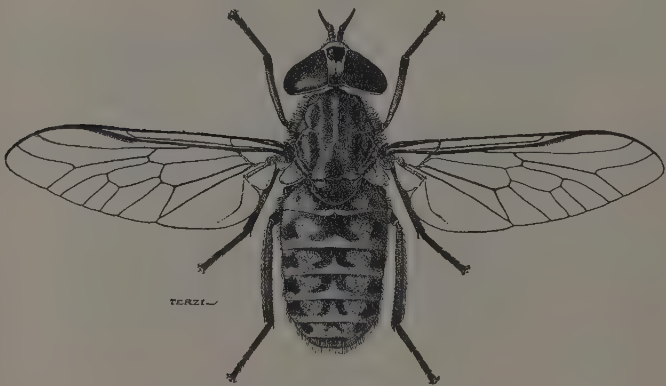


Fig. 1.—*Silvius fallax*, Austen, ♀. × 4.

*Head*, except vertical triangle in ♂ and frontal callus and area surrounding ocelli in ♀, light grey pollinose; when denuded, face and jowls in both sexes and sub-callus in ♀ fawn-coloured; vertical triangle in ♂ and area surrounding ocelli in ♀ clove-brown; *frontal callus* in ♀ chestnut or burnt-umber coloured, large, narrowly separated from eye on each side, more or less quadrate in outline, but with rounded angles; face, jowls, and basi-occipital region clothed with whitish hair, in ♂ outer border of face, jowls, and basi-occipital region clothed with dark brown or brownish hair; eyes in ♂ densely clothed with fine grey hair, and rather more than their upper halves (except hind borders) consisting of larger facets than elsewhere; *palpi* ochraceous-buff, clothed with whitish hair, which on upper surface of terminal joint in ♂ is often intermixed with dark hair;

* For names and illustrations of colours, *see* Ridgway, "A Nomenclature of Colors for Naturalists." (Boston: Little, Brown & Company, 1886.)

first and second joints of *antennae* greyish clove-brown (first joint in ♀ often greyish chestnut-brown), first joint short, swollen distally especially in ♂, first and second joints clothed above with blackish and below with whitish hair, hair on first joint much longer and denser in ♂ than in ♀, third joint of antennae clove-brown, with a prominent angle on upper margin of its expanded basal portion, which (in ♀ at any rate) is broader than in *S. decipiens*, Lw. *Thorax*: dorsum in ♂ with an exceedingly slender, median, grey longitudinal stripe (easily overlooked) on its anterior half, and on each side of this a broader and more conspicuous stripe running from front margin to inner extremity of lateral half of transverse suture, beyond which indistinct continuations of both admedian and median stripes can sometimes be perceived, the admedian stripes each widening out into a rounded expansion midway between suture and prescutellar groove; dorsum of thorax in ♂ clothed with light grey hair, except between bases of wings where there is a transverse band of dark brown hair, in front of which, to a point midway between band and anterior margin of dorsum, brownish hairs may be intermixed with the grey ones; pleurae and pectus in ♂ slate-grey and clothed with greyish hair; dorsum of thorax in ♀ with five longitudinal grey stripes, consisting of a broader pair on each lateral half, which extend from front to hind margin and are obliquely connected by the grey transverse suture, and a narrow median stripe, which also commences on front margin but becomes indistinct soon after passing transverse suture; admedian stripes in ♀ exhibiting, as in ♂, expansions midway between transverse suture and prescutellar groove; hairy covering of dorsum of thorax in ♀ similar to that in ♂, but shorter; pleurae and pectus in ♀ fawn-coloured, greyish pollinose and clothed with greyish-white hair. *Abdomen*: black median stripe on dorsum of ♂ often with wide lateral extensions at base of second segment, in front of grey spots, narrower on third and fourth segments, interrupted by the grey hind borders of the second and third segments, and on each side indented more or less deeply by the paired grey spots; dorsum of first segment in ♂ black or clove-brown except posterior angles, which are buff or cream-buff and, like lateral borders of same segment, clothed with whitish hair; dorsum of second and two following segments in ♂ each with a pair of grey spots, contrasting more or less distinctly with ground colour and connected with hind border, which is also grey and in middle line expanded into a forwardly-directed triangle; tergites of three following segments clove-brown in ♂, with hind margins narrowly grey or isabella-coloured, fifth and sixth segments also each with a pair of grey spots, and fifth segment in addition with a grey median triangle resting on hind margin; sides of tergites of second and two following segments in ♂ (except hind borders) more or less dark brown and clothed with dark hair; dorsum in ♂ clothed mainly with dark brown or blackish hair; hind border (including posterior angles) of second segment, posterior angles of third and fourth segments, and lateral margins of fifth and following segments clothed with whitish hair; venter in ♂ mainly buff, clothed with greyish-white hair, first segment slate-grey, second segment with a large, quadrate, greyish clove-brown blotch in centre (sometimes indistinct), resting on base but not reaching hind border, fifth and following segments greyish clove-brown, hind margins of second and following

segments cream-buff or cream-coloured : dorsum in ♀ marked as shown in fig. 1, and clothed mainly with minute, appressed, blackish hairs, lateral margins and posterior angles of first six segments, as also bases of median triangles clothed with whitish hair ; venter in ♀ greyish ochraceous-buff, hind margins of second and following segments cream-buff or cream-coloured, second to sixth segments inclusive clothed with minute, appressed, glistening whitish hairs, which are longer than elsewhere at each lateral extremity of hind border of sixth segment, last segment clothed with blackish hair. *Wings* narrow and elongate ; auxiliary and first longitudinal veins, and bases of second, third, and fifth longitudinal veins cinnamon or mummy-brown, remaining veins for most part dark brown ; *stigma* either indistinguishable, or narrow, elongate, raw-umber-coloured, and not sharply defined. *Squamae* shining and glassy, with a faint yellowish tinge. *Halteres* clove-brown, stalks paler, tips of knobs also occasionally pale. *Legs* : coxae slate-grey or dark grey (front pair in ♀ more or less fawn-coloured beneath the usual pollinose covering), clothed with whitish hair ; femora and tibiae russet-brown or cinnamon-rufous, in ♂ proximal third and distal extremities of front femora, distal extremities and an elongate blotch on under side of base of middle femora, and under surface and tips of hind femora clove-brown, distal halves of front tibiae in ♂ clove-brown beneath, tips of hind tibiae in ♂ also clove-brown, distal extremities of tibiae in ♀ dark brown or brownish ; femora clothed with whitish hair, hind tibiae in ♂ with a fringe of fairly long, dark brown hair on both inner and outer surfaces, hind tibiae in ♀ with a fringe of very short hair on outer side, sometimes wholly whitish, sometimes dark brown except at base ; tarsi clove-brown in both sexes, proximal half or two-thirds of first joint of middle or of both middle and hind tarsi more or less distinctly cinnamon-rufous or chestnut ; apical spines on hind tibiae small.

North-Eastern Rhodesia : type of ♂, type of ♀, and two para-types of each sex, on road between Petauke and Hargreaves, Luangwa Valley, 16. ix. 1910, "at water-hole" ; additional para-types as follows :— 2 ♂ ♂, 1 ♀, near mouth of Lusangazi River, Luangwa Valley, 1–3. ix. 1910 ; 1 ♀, Chirimanyama Stream, 8 miles south of Hargreaves, 11. ix. 1910 ; 1 ♀, Lower Luangwa River, 13. ix. 1910 ; 8 ♂ ♂, 8 ♀ ♀, Namadzi Stream, 30 miles south-east of Hargreaves, 14. ix. 1910 ; 1 ♂, 1 ♀, near Petauke, 2,400 ft., 18–20. ix. 1910 ; 1 ♀, Msoro, Petauke—Fort Jameson Road, 24. ix. 1910 ; 1 ♂, 25 miles west of Fort Jameson, 25. ix. 1910.

Besides the foregoing specimens all of which were collected by Mr. *S. A. Neave*, and presented to the British Museum (Natural History) by the Entomological Research Committee, no fewer than three hundred and forty other examples of *Silvius fallax*, including sixty-three males and two hundred and seventy-seven ♀ ♀ were obtained by Mr. Neave in the Lower Luangwa Valley, from Hargreaves to the Lutembwe River (fifteen miles west of Fort Jameson), between September 14 and 26, 1910.

*Silvius decipiens*, Lw., to which reference was made at the commencement of the diagnosis of *S. fallax*, is apparently found to the south of the area occupied by the latter. Originally described from specimens from "Caffraria," *Silvius decipiens* is represented in the National Collection by ten ♀ ♀ from the Tamulakan

River (north-east of Lake Ngami), Bechuanaland Protectorate, 20. ix. 1909 (*R. B. Woosnam*); one ♀ from Buluwayo, 12. ix. 1909, "attacking man during the heat of the day" (*E. C. Chubb*); and one ♀ from the Mafungabusi District, Southern Rhodesia, 17. ix. 1910 (*R. W. Jack*).

## Genus Cadicera, Macq.

### Cadicera biclausa, Lw.

*Pangonia biclausa*, Loew, Öfvers. af Kongl. Vetensk.-Akad. Förhandl., xiv, p. 337 (1857); Abhandl. des Naturwiss. Vereins für Sachsen und Thüringen, ii, p. 91 (1860); 'Die Dipteren-Fauna Südafrica's,' p. 19 (1860).

*Cadicera nigrescens*, Ricardo, Annals and Magazine of Natural History, Ser. 7, vol. vi, p. 161 (1900).

*Cadicera nigricolor*, Austen, Annals and Magazine of Natural History, Ser. 8, vol. vi, p. 342 (1910).

The foregoing synonymy is the result of the acquisition by the British Museum (Natural History) of the type of *Cadicera nigrescens*, Ricardo (formerly in the collection of Mr. W. L. Distant), and of five specimens (2 ♂♂ and 3 ♀♀—the latter caught in the act of "attacking man") of *Cadicera nigricolor*, Austen, from the Chirinda Forest, Melsetter District, Southern Rhodesia, 10–12.X.1911 (*C. F. M. Swynnerton*: presented by the Entomological Research Committee).

The study of this material shows that all the specimens examined belong to one species, which must be designated *Cadicera biclausa*, Lw.; and that, whereas the abdomen of *C. biclausa*, Lw., is sometimes uniformly purplish-black in both sexes, in other cases, in one or both sexes, the distal extremity of the abdomen is, or at least the lateral borders or posterior angles of the third or fourth and following segments are ferruginous or burnt-sienna-coloured.

The female of *Cadicera biclausa*, Lw., is distinguished from that of *C. rubramarginata*, Macq.,* by the more slender shape of the terminal joint of its palpi, by the presence of a pair of small, elongate, greyish-white spots on the anterior margin of the thorax, between the humeral calli, and by the absence of a median ferruginous stripe or spear-shaped mark on the tergites of the second and third abdominal segments. It may be noted that what Loew calls a "variety" of his species would appear to be in reality *C. rubramarginata*, Macq.

Since the type of *C. nigrescens*, Ric., is from Zomba, it is evident that the range of *C. biclausa*, Lw.,—which was described from a specimen from Bechuanaland, and is represented in the Museum collection by a male from Pretoria (*W. L. Distant*), in addition to the specimens already mentioned—extends to the north at least as far as the Nyasaland Protectorate.

### Cadicera chrysopila, Macq.

*Pangonia chrysopila*, Macquart, Hist. Nat. des. Ins. Diptères, I, p. 194 (1834).

This species is evidently a *Cadicera*, and, so far as it is possible to judge from the description, *Pangonia nobilis*, Wied. (Auss. zw. Ins. II, p. 622 (1830)), also belongs to the same genus. Miss Ricardo (Ann. Mag. Nat. Hist., ser. 8, vol. i,

* For coloured figure of this species *see* Austen, 'Illustrations of African Blood-Sucking Flies,' Plate III, fig. 19 (1909).

p. 56 (1908)) has pointed out that the two names apparently refer to the same species, and that if this be so *P. chrysopila*, Macq., is a synonym of *P. nobilis*, Wied.; without making a comparison of the types the matter cannot, however, be decided definitely. Of *P. nobilis*, the type (from the Cape of Good Hope) is in the Berlin Museum; the type of *P. chrysopila*, the provenance of which is given by Macquart simply as "Afrique," is in all probability lost. It is stated by Macquart to have originally been in M. Serville's collection, which, according to Osten Sacken (Cat. Dipt. N. America, p. xvi (1878)), eventually passed into the possession of the late M. Bigot. As most Dipterists are aware, Bigot's collection on the death of its owner was acquired by the late Mr. G. H. Verrall, by whom it was bequeathed in 1911 to his nephew, Mr. J. E. Collin. In reply to enquiries, Mr. Collin has been good enough to inform the writer that the type of *Pangonia chrysopila*, Macq., is not in the Bigot collection, and that he cannot find the name in the catalogue of the collection made when it passed into Mr. Verrall's hands.

A female *Cadicera* from Barberton, Transvaal (*Dr. P. Rendall*) recently acquired by the British Museum (Natural History) apparently belongs to the species under consideration.

**Cadicera distanti**, sp. n.

♂.—Length (one specimen) 17 mm.; width of head 5·5 mm.; length of proboscis 4·4 mm.; length of wing 15·4 mm.

*Body shining black, marked on dorsal surface with spots and patches of bright chrome-yellow pile, distal extremity of abdomen tawny-ochraceous; wings, except at distal extremity, ochre-yellow, distal extremity of marginal cell (from level of distal extremity of discal cell) and area intervening between this and posterior branch of third longitudinal vein dark sepia-coloured, extreme tip of wing, all posterior cells, distal extremity of axillary cell, and distal two-thirds of discal cell light sepia-coloured.*

*Head* mummy-brown, frontal triangle brownish-grey pollinose, facial orbits grey pollinose, occiput smoke-grey above and on orbits, dark sepia-coloured in centre and below, jowls and basi-occipital region clove-brown; ocelli wanting; basi-occipital region, lower half of posterior orbits, and posterior portion of jowls clothed with Naples-yellow hair, anterior portion of jowls clothed with black hair, sides of face clothed partly with black, partly with yellow hair; proximal joint of *palpi* clove-brown or black, clothed at base with Naples-yellow hair and elsewhere with black hair, terminal joint of palpi narrow, curved, and pointed at distal extremity, ochraceous at distal extremity and on inner surface, proximal three-fourths of outer surface dark brown and clothed with black hair, distal extremity clothed with shining ochraceous hair; first and second joints of *antennae* burnt-umber-coloured, clothed with black hair, third joint ferruginous. *Thorax*: dorsum in front with a pair of narrow, cuneate, longitudinal grey marks, each of which is situate approximately midway between median line and lateral margin, and, commencing on front margin, dies away midway between latter and transverse suture; chrome-yellow pile on dorsum arranged as follows—a tuft on anterior extremity of each humeral callus, a large and conspicuous patch on each side occupying the presutural depression, a thick fringe clothing outer border

of each postalar callus, and a pair of admedian tufts in front of scutellum on hind margin of main portion of dorsum, *unconnected with each other or with fringes on postalar calli*; dorsum elsewhere clothed with short black hair, pleurae and pectus clothed with longer black hair. *Abdomen:* dorsum of second segment with a large patch of appressed, bright chrome-yellow hair on each side, not quite reaching lateral margin; dorsum of fourth segment with a very small median tuft of chrome-yellow hairs on hind border; posterior angles of dorsal scute of fifth segment tawny-ochraceous and clothed with similarly coloured hair; tawny-ochraceous area at distal extremity clothed with similarly coloured hair, sixth segment black at base, then tawny-ochraceous, seventh segment entirely tawny-ochraceous; ventral scute of second segment with a small patch of appressed, Naples-yellow hair on each side; ventral scute of fifth segment with some tawny-ochraceous hairs near hind border, dorsal scute of same segment with a few similar hairs towards hind border; abdomen except as stated clothed with minute, appressed, black hairs. *Wings:* costa (except extreme base, which is darker) and first longitudinal vein ochraceous, remaining veins in yellow portion ochre-yellow. *Squamae* cream-buff. *Halteres:* knobs ochraceous-buff, stalks dark-brown. *Legs:* coxae clove-brown or black, clothed with black hair; femora (middle legs missing in case of type) cinnamon-rufous; front tibiae and tarsi ochraceous-rufous, hind tibiae and tarsi tawny-ochraceous or ochraceous.

TRANSVAAL: Natal border, near Newcastle (*W. L. Distant*).

This handsome species, which is named in honour of its discoverer, in general appearance presents resemblances to *C. chrysopila*, Macq., and *C. chrysostigma*, Wied., from both of which, however, it is distinguished *inter alia* by the spots or tufts of chrome-yellow hair on the dorsum of the thorax all being separate, instead of the tuft in the presutural depression being connected with that on the humeral callus on each side, and the spots on the hind border being each continuous with the fringe on the postalar callus on the same side. From both the species mentioned *C. distanti* is further distinguishable by the abdomen (ventral and dorsal surfaces) being differently or less extensively spotted with patches of yellow hair.

**Cadicera obscura,** Ric.

*Corizoneura obscura*, Ricardo, Ann. Mag. Nat. Hist. ser. 8, vol. i, p. 56 (1908).

Owing to a combination of characters (namely, the shape of the face, and the size and position of the terminal joints of the palpi, which, although pointed at the tips, are large and raised above the proboscis, instead of small, and situate alongside or closely approximate to the base of the latter), it would seem advisable to transfer this species to the genus *Cadicera*. With the two new species described below, *C. obscura* forms a group characterised by having the abdomen narrower than in the more typical forms, and the first posterior cell in the wings either more or less narrowly open, or else closed on or immediately before the hind margin, instead of closed some distance before reaching the latter, and consequently pedunculate.

The type of *Cadicera obscura*, obtained at Blantyre, Nyasaland Protectorate in November, 1904, by Dr. J. E. S. Old, is the only specimen of this species yet received by the British Museum (Natural History).

**Cadicera speciosa**, sp. n. (fig. 2).

♀.—Length (4 specimens) 16·25 to 16·75 mm.; width of head 5·4 to 5·6 mm.; width of front at vertex 0·75 mm.; length of proboscis 3·5 to 4·5 mm.; length of wing 16 to 17 mm.

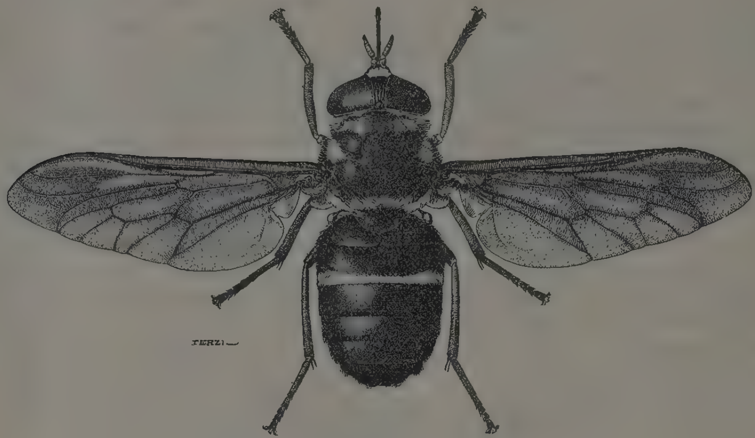

Fig. 2.—*Cadicera speciosa*, Austen, ♀. × 3.

*Black, dorsum of thorax with markings of bright ochre-yellow pile, abdomen with a band of silvery hairs; wings, especially next veins, either more or less tawny-ochraceous (except tips, which are dark brown), or dark brown, except extreme base, costal cells, and proximal portions of principal veins, which are tawny-ochraceous.—Presenting a deceptive superficial resemblance to* C. obscura, *Ric., but distinguishable* inter alia *by the bright ferruginous or cinnamon-rufous coloration of the antennae, legs, and the terminal joint of the palpi; by the terminal joint of the palpi being less acuminate, and clothed mainly with ochraceous or ochraceous-rufous, instead of with dark brown or brownish hairs; by the mesopleurae being entirely clothed with black hairs, instead of for the most part with pale yellowish hairs; and by the presence of a conspicuous band of short, appressed, glistening silvery-white hairs on the hind border of the tergite of the second abdominal segment.*

*Head:* front and face shining black, former rugose above callus; between latter and antennae is a transverse band of dull, yellowish-grey pollen, which sends off a narrow, downward offshoot along each side of face, next inner margin of eye; sides of face, basi-occipital region, and lower portion of posterior orbits clothed with buff-yellow hair; occiput, except small quadrate area immediately below vertex, yellowish-grey pollinose; ocelli wanting; proximal joint of *palpi* greyish clove-brown, lower surface clothed proximally with buff-yellow and distally with dark brown or blackish hairs, terminal joint of palpi elongate, bluntly pointed at tip; first and second joints of *antennae* somewhat darker than third joint. *Thorax:* front border of dorsum clothed with appressed, bright ochre-yellow hairs, which on median third are somewhat sparser than elsewhere; hind margin of main portion of dorsum, in front of scutellum and including outer

surface of postalar calli, with a narrower border of similar hairs, more closely set and sometimes also somewhat paler than in front; depth of hind border little more than half that of fore border; on each side of dorsum, occupying presutural depression immediately in front of outer end of transverse suture, is a large patch of bright ochre-yellow hairs, which sends off a narrow prolongation a little way along transverse suture; remainder of main portion of dorsum moderately shining, and clothed with appressed black hairs; *scutellum* dull black, clothed with appressed black hairs, and with its upper surface minutely granular; pleurae and pectus clothed with black hair, except that there is an oblique stripe of ochre-yellow hair below base of each wing. *Abdomen* shining black, except dorsum of first segment, which is dull black; dorsum, except hind border of second segment, clothed with minute, appressed, black hairs; band of silvery-white hairs on second segment deeper toward sides than in middle (varying in depth in different specimens), but not quite reaching lateral margins; ventral scute of second (visible) segment with a large patch of shining silvery-white hairs on each side, towards hind margin; ventral scute of fourth segment with a few yellowish hairs on each side. *Wings:* discal and certain other cells sometimes each with a paler streak in centre; first posterior cell either narrowly open or else closed on wing-margin, in some specimens closed in one wing and open in the other. *Squamae* dull waxen-white. *Halteres* dark brown, tips of knobs ochraceous-buff. *Legs:* coxae black and clothed with black hairs; femora, especially towards base, somewhat darker than tibiae and tarsi, and clothed above with black hairs; tibiae and tarsi clothed with ferruginous hairs; claws black, ferruginous at base.

German East Africa: type and three other specimens (para-types) from the Iringa-Kilossa Road, at foot of Kifulufulu Mt., Usangu District, alt. 3,000 ft., 16, 17. xii. 1910 (*S. A. Neave*). Type and two para-types presented to the National Collection by the Entomological Research Committee; remaining para-type in possession of the Committee.

### **Cadicera flavicoma**, sp. n.

♀.—Length (1 specimen) 15·5 mm.; width of head 5 mm.; width of front at vertex just under 1 mm.; length of proboscis 3·5 mm.; length of wing 15 mm.

*Front and face cinnamon-rufous; antennae ferruginous; terminal joint of palpi orange-rufous; body black or clove-brown, marked with patches of bright Naples-yellow pile; last two segments of abdomen cinnamon-rufous or orange-rufous, hind borders of other abdominal segments (more or less distinctly) cinnamon-rufous; wings with an ochre-yellow tinge, distal third dark sepia-coloured.—Resembling* C. obscura, *Ric., in general appearance, but distinguishable at once by the front and face not being black, as also by the coloration of the antennae, and the orange-rufous hue of the femora and terminal joint of the palpi; the terminal joint of the palpi is also different in shape, and clothed with bright ochraceous-rufous instead of with dark brown or brownish hair.*

*Head:* front strongly rugose above callus; ocelli wanting; between callus and antennae is a transverse band of grey pollen, which sends off an offshoot down each side of face, next inner margin of eye; occiput (except quadrate area

immediately below vertex) and basi-occipital region smoke-grey pollinose, basi-occipital region and lower portion of posterior orbits clothed with Naples-yellow hair, lower portion of sides of face next eyes sparsely clothed with minute ochraceous-buff hairs ; proximal joint of *palpi* dark brown (reddish at extreme tip), clothed below with yellowish hairs, terminal joint shaped like a banana ; first and second joints of *antennae* greyish pollinose, sparsely clothed with yellowish hairs. *Thorax:* bright Naples-yellow hair on dorsum arranged exactly like the ochre-yellow hair in the case of the foregoing species ; fore-border of Naples-yellow hairs absent from rather less than middle third, except for a few scattered hairs ; pleurae with an oblique fringe of yellowish hairs below base of each wing, elsewhere clothed with black hairs ; dorsum, except as already stated, clothed with minute appressed black hairs. *Abdomen:* dorsum of first segment with a few appressed, bright Naples-yellow hairs in middle line, next hind margin ; dorsum of second segment clothed with similar hairs, except on anterior half of each lateral third ; dorsum of third segment with a minute patch of similar hairs on hind border, in middle line ; median third of dorsum of each of the three following segments clothed with similar hairs ; lateral margins of tergites of last two segments clothed with ochraceous-rufous hairs ; dorsum, except as stated, clothed with minute, appressed, black hairs ; ventral scutes of second, fourth, and fifth segments each bearing on each side a large quadrate patch of bright, pale Naples-yellow hairs ; ventral scute of third segment on each side similarly but more sparsely clothed ; ventral scutes of last two segments clothed with ochraceous-rufous hair, except each lateral extremity of penultimate segment, which is clothed with Naples-yellow hair ; venter, except as stated, clothed with minute, appressed, black hairs, which however on median portion of fourth and fifth segments are interspersed with minute ochraceous-rufous hairs. *Wings:* costa and first longitudinal vein ochraceous-rufous, other veins, except within dark area, ochraceous ; first posterior cell narrowly open (at least in case of type). *Squamae* cream-coloured. *Halteres:* knobs cream-buff, pale cinnamon-coloured on each of their broader faces, stalks mummy-brown. *Legs:* coxae burnt-umber-coloured, clothed with black hair, hind coxae with Naples-yellow hair on outer side ; femora orange-rufous, extreme tips paler (cream-buff) ; front tibiae ochraceous-rufous, cream-buff at base on anterior surface ; middle and hind tibiae somewhat slender, cream-buff, distal extremities ochraceous-rufous ; tarsi ochraceous-rufous ; hair on upper side of front femora and on anterior surface of middle femora, except at distal extremities of both, black.

NYASALAND PROTECTORATE ; Blantyre, October or November, 1909 (*Dr. J. E. S. Old*).

### Genus PANGONIA, Latr.

**Pangonia comata,** sp. n. (fig. 3).

♂.—Length (3 specimens) 10·5 to 11 mm. ; width of head 4 to 4·4 mm. ; length of proboscis, *exclusive of labella*, 3 to 3·75 mm. ; length of labella 1 mm. ; length of wing 10·4 to 10·8 mm.

*Small species, densely clothed with short, fine hair ; dorsum of thorax grey or slate-grey, on each side with two oblique, elongate, clove-brown patches, one in front of and one behind transverse suture ; dorsum of abdomen black, with three transverse*

*bands of white hair on a grey ground, white hair forming first band (on hind border of first segment) most conspicuous at each side; distal portion and hind border of wings tinged with mouse-grey; femora black, tibiae and tarsi clove-brown, dark sepia-coloured, or mummy-brown.*

*Head:* frontal triangle and face light grey pollinose, face short, not prominent, clothed on each side with whitish hair and devoid of shining calli; jowls clove-brown, clothed with similarly coloured or blackish hair; basioccipital region and hind border of posterior orbits clothed with whitish hair; occiput smoke-grey pollinose; *palpi* clove-brown, proximal joint clothed below with whitish hair,


Fig. 3.—*Pangonia comata*, Austen, ♂. x 4.

terminal joint seen from the side noticeably curved at the distal extremity, which is clothed with clove-brown hair; first joint of *antennae* greyish clove-brown, clothed above and below with black hairs, second and third joints clove-brown or very dark brown; *labella* large and gaping, and (at least in dead specimens) projecting upwards and forwards at an angle of about or rather more than 90° with axis of proboscis, each labellum armed below with five long, narrow, fringed laminae similar to but larger than those exhibited by the labella of *Dorcaloemus silverlocki* (*see* p. 124). *Thorax:* dorsum clothed with grey hair mixed with black hair, both grey and black hair upstanding, fine, silky, and crinkled; pleurae and pectus grey, clothed with greyish-white hair. *Abdomen:* hairy covering shorter than that of thorax, and the individual hairs not crinkled; hind borders of dorsal scutes of first, second, and fourth segments grey and clothed with glistening white hair, ground colour of grey border of first segment sometimes more or less distinctly buff on each side, grey borders of first and second segments deeper at each lateral extremity, hind border of dorsal scute of third segment appearing dark grey when abdomen is viewed at a low angle from behind, but bearing white hairs only at its extreme lateral extremities, lateral

margins and posterior angles of fifth and sixth segments clothed with white hairs; dorsum of abdomen, except as stated, clothed with short, dense, black hair; ventral scutes of first and second segments grey, second segment clothed with glistening white hair and its ground colour sometimes greyish-buff at base, hind border of ventral scute of third segment with a few glistening white hairs on each side, ventral scute of fourth segment grey and clothed except in middle with glistening white hairs, ventral surface of abdomen, except as stated, black and clothed with black hair. *Wings:* extreme base, first and second costal cells, distal extremity of third costal cell, stigma, and anterior margin of first basal cell ochreous. *Squamae* cream-coloured, borders cream-buff. *Halteres:* knobs sepia-coloured, stalks somewhat paler. *Legs:* coxae grey, clothed with greyish-white hair, femora, tibiae, and tarsi clothed with black hair.

East Africa Protectorate: Rabai, 15. iii. 1912 (*S. A. Neave:* presented to the National Collection by the Entomological Research Committee).

The following field-note has been supplied by Mr. Neave:—"The three individuals of this small black *Pangonia* were taken on a forested hill near Rabai, at an altitude of about 600 ft. Two specimens were captured about 10 a.m., within a few yards of each other. In spite of a careful search, no others were even seen during the day, with the exception of the third individual, which was caught about 2 p.m., on the identical spot where the others were found."

*Pangonia comata* cannot be confused with any other African species of *Pangonia* at present known. Owing to the shortness of its face and the absence therefrom of shining calli, its affinities would appear to be with the group formed by the South African *Pangonia conjuncta*, Walk., *P. angulata*, Fabr., and *P. alboatra*, Walk., from all of which, however, it may at once be distinguished, apart from other characters, by its much smaller size and by the nature of the hair on the abdomen, which, instead of being exceedingly short and appressed, is longer, upstanding, and furry.

### Genus Dorcaloemus, Austen.

**Dorcaloemus silverlocki**, sp. n.

♀.—Length (2 specimens) 13 to 13·5 mm.; width of head 4 to 4·2 mm.; width of front at vertex 0·6 mm.; distance from upper margin of occiput to anterior extremity of face 3·25 mm.; length of proboscis just under 4·5 mm.; greatest width of abdomen (across base of second segment) 5·2 mm.; length of wing 10·25 to 11 mm.

*A relatively narrow-bodied, elongate species, in shape resembling* Dorcaloemus bicolor, *Austen.—Face short; dorsum of thorax blackish slate-coloured, with a greyish bloom, and clothed with ochre-yellow hair mixed with blackish hairs; dorsum of abdomen ochraceous or tawny-ochraceous (first segment greyish cream-buff) with black markings, and clothed with short, appressed, glistening orange-ochraceous hair; wings ochreous, distal third and hind border somewhat darker; femora black, tibiae, tarsi, and extreme tips of femora cream-buff.*

*Head* light grey, a roughly triangular area on each side, occupying lower part of sides of face and anterior portion of jowls clove-brown; *frontal callus* large, bluntly sagittate and shining black, narrowly separated from eye on each side

and extending from middle of front to ocellar region of vertex, which is slate-grey; upper portion of sides of face, except orbits, thinly clothed with whitish hair, basi-occipital region and posterior orbits clothed with yellowish or whitish hair; *palpi* clove-brown; first joint of *antennae* greyish clove-brown, second joint greyish fawn-coloured, third joint cinnamon, large, broad at base. *Thorax:* lateral borders of dorsum grey pollinose; ground colour of pleurae and pectus agreeing with that of dorsum, pleurae clothed with yellowish or whitish hair. *Abdomen:* tergite of first segment with a large black blotch at base, extending beyond scutellum but not reaching basal angles or hind margin; hair on tergite of first segment sometimes entirely ochreous, sometimes black on black blotch and silvery-white on hind border; tergites of second and third segments each with a large, median, black spot, resting on or closely approximate to base of segment in each case, and either not quite reaching hind margin or barely extending beyond middle of segment; spot on second segment the larger, and (at least in case of type and para-type) bluntly triangular, with its apex directed backwards, spot on third segment rounded or more or less quadrate in outline; black spots and adjacent area on second and third segments clothed in part with minute black hairs; tergites of fourth to sixth segments inclusive each with a black transverse band at base, band on fourth segment in case of type contracted towards each lateral extremity in such a way that the segment is ochraceous both in front of and behind it; hind borders of tergites of third to sixth segments inclusive sometimes yellowish-grey pollinose, with median expansions which, on fourth and fifth segments, may reach front margin; tergite of seventh segment wholly black, more or less yellowish-grey pollinose, and clothed with black hair intermixed with orange-ochraceous hair; ventral surface of abdomen buff or cream-buff in front, black at distal extremity, third and fourth segments (except hind borders) more or less burnt-umber-coloured (fourth segment sometimes largely dark brown), hind borders of second, third, and fourth segments cream-coloured, second segment and hind borders of two following segments clothed with silvery-white, whitish, yellowish, or ochreous hair, lateral extremities of hind borders of fifth and sixth segments clothed with ochre-yellow hair, third and following segments, except as already stated, clothed mainly with minute, appressed, black hairs. *Squamae* cream-coloured. *Halteres:* knobs seal-brown on each of their broader faces, intervening area cream-coloured; stalks buff. *Legs:* coxae grey, clothed with yellowish or whitish hair; femora clothed with black hair; upper surface of tibiae and tarsi clothed with minute, glistening, whitish or yellowish hairs.

NORTHERN RHODESIA: Gwai River, March, 1911 (*the late O. C. Silverlock*).

This species is dedicated to the memory of its discoverer, a young entomologist in the service of the British South Africa Company, who, shortly after the specimens described above were collected, unfortunately lost his life in the River Zambesi, through the upsetting of his canoe by a hippopotamus.

As indicated by the shape of the body, *Dorcaloemus silverlocki* is allied to *D. bicolor*, Austen (in which the face is likewise short), more nearly than to any other of its congeners yet described; the present species can however at once be distinguished from *D. bicolor* by the coloration of the abdomen, and of the hairy

covering of the dorsal surface of the latter. In the shortness of the face and of the proboscis, as well as in the coloration and markings of the abdomen, the new species also displays affinity to *Dorcaloemus fodiens*, Austen, and *D. woosnami*, Austen, although from both of these *D. silverlocki* is distinguishable by the narrow and elongate shape of the body, the larger size of the frontal callus, and the conspicuous coat of bright orange-ochraceous hair on the dorsal surface of the abdomen.

The specimen selected as the type of *D. silverlocki* exhibits a number of remarkable, narrow, elongate, fringed laminae projecting from the inner surfaces of its divergent labella, similar to the corresponding structures exhibited by the foregoing species (*q.v.*) ; the determination of the exact nature of these processes must be postponed until the acquisition of further material.

## Genus Subpangonia, Surcouf.

The genus *Subpangonia* (originally characterised by its describer as a "subgenus") is distinguished from *Pangonia*, Latr., by its remarkable proboscis. This organ, which, in dead specimens at any rate, slants downwards at an obtuse angle with the longitudinal axis of the body, is of only moderate length or relatively short, and, instead of being slender and needle-like in appearance, looks thick and fleshy. The most striking external features of the proboscis are exhibited by the labella, which, instead of being small, inconspicuous, and narrow at the tips, are extraordinarily large, blunt-ended, and rather longer than or at least as long as half the total length of the proboscis. From the upper margin of the inner surface of each labellum there projects downwards, at an angle with the axis of the proboscis, a series of light-coloured or reddish, rod-like processes, which are broader at the base and narrower at the tip, and diminish successively in length. Each labellum apparently bears ten or eleven of these rod-like structures, the proximal five or six of which are longer than the remainder, and (in dead specimens at any rate) protrude conspicuously below the lower ends of the rest, of which the extreme tips alone are visible from the outer side. Surcouf* describes the rod-like processes as "almost completely closed tubes," and says that their function would appear to be to assist the insect in sucking up blood or other fluids. By means of a mere external examination the present writer has not been able to satisfy himself that the bodies in question are really tubular, and their precise structure and significance remain to be determined ; meanwhile the attention of the reader may be directed to the existence of apparently homologous processes on the inner surfaces of the labella in *Dorcaloemus silverlocki*, Austen (*supra*), and *Pangonia comata*, Austen (*see* p. 123).

The blunt ends of the labella are somewhat shining on the outer side, and are sparsely but rather coarsely punctured. At the base of the labella the labium broadens out on each side into a thickened flange-like extension ; these flanges embrace the labrum, on the upper surface of which their edges almost meet together. When the head of the insect is viewed in profile, the flange-like

* Bulletin du Muséum National D'Histoire Naturelle, 1908, No. 6, p. 284 (Paris : October, 1908).

extension looks like an elongate-ovate swelling in the middle of or just before the middle of the under side of the proboscis.

The only species of *Subpangonia* yet described is the geno-type, *S. gravoti*, Surcouf,* of which the typical series was obtained in French Congo, near the southern boundary of Kamerun, in July and August, 1906. The new species characterised below, examples of which have been received from Ashanti and Southern Nigeria, closely resembles *S. gravoti*, of which, by the courtesy of Baron J. M. R. Surcouf, a para-type is now in the British Museum.

**Subpangonia grahami**, sp. n. (fig. 4).

♀.—Length (3 specimens) 12·2 to 13·5 mm.; width of head 4·2 to 4·6 mm.; width of front at vertex 0·6 mm.; length of proboscis 3·5 to 3·8 mm.; length of labella 2 to 2·25 mm.; length of wing 12·8 to 14 mm.

Fig. 4.—*Subpangonia grahami*, Austen, ♀. × 2½.

*Dorsum of thorax clove-brown, with conspicuous dull olive, grey, or yellowish-grey pollinose markings; dorsum of abdomen, dusky tawny, moderately shining, last three or last four segments clove-brown, hind borders of second, fourth, and two following segments, at least towards lateral extremities, clothed with silvery-white hair; wings strongly tinged with raw umber; legs clove-brown or dark brown.*

*Head* yellowish-grey pollinose, lower part of sides of face and anterior portion of jowls clove-brown; face short, clothed on each side with yellowish hair; basioccipital region clothed with whitish hair; ocelli wanting; vertex blackish clove-brown; upper half of front with a dark brown, sagittate mark, central portion of which when rubbed looks like a low, ill-defined, blackish callus, and of which the apex is in contact with the dark area occupying the vertex; extending upwards from base of each antenna is a dark brown, elongate mark, the upper extremity of which is more or less distinctly bifurcate but does not reach the sagittate mark; *palpi* clove-brown, small, terminal joint narrow and curved, proximal joint clothed below with blackish hair; first and second joints of *antennae* clove-brown, dusky grey pollinose, clothed with blackish hair, which is

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* *Loc. cit.*, p. 283.

especially long on upper surface of first joint, third joint of antennae clove-brown, dark brown, or dark cinnamon-rufous, proximal portion broad. *Thorax:* dorsum with a broad median longitudinal stripe (sometimes divided), humeral and prealar calli (except sometimes anterior extremities of latter), postalar calli and lateral margins between latter and transverse suture, transverse suture itself, and scutellum dull olive, grey, or yellowish-grey pollinose; two clove-brown areas (one in front of and one behind transverse suture) on each side of median pollinose stripe, area behind transverse suture narrower and longer than the other; dorsum clothed with fine erect blackish hair, more or less interspersed, especially towards each side, with short appressed ochreous hair; postalar calli and area immediately above base of each wing clothed with longer, pale yellowish hair; pleurae and pectus light grey, clothed with whitish hair. *Abdomen:* dorsum clothed mainly with minute, appressed, black hairs; lateral margins and posterior angles of first segment clothed with whitish hair; dorsum of second and third segments, at least in centre and towards lateral extremities, showing more or less ill-defined traces of clove-brown pigment, dorsum of fourth segment sometimes almost wholly clove-brown, sometimes partly tawny; coloration of venter agreeing generally with that of dorsum. *Squamae* yellowish, or light raw-sienna-coloured. *Halteres* dark sepia-coloured, tips of knobs paler. *Legs:* coxae grey, clothed with whitish hair; hind tibiae clothed with fine, short, outstanding blackish hair.

ASHANTI and SOUTHERN NIGERIA: type from Obuasi, Ashanti, 24. vi. 1907, "caught on Sansu trolly line near stream" (*Dr. W. M. Graham, W.A.M.S.*); a second specimen (para-type) from same locality, 27. vi. 1907, "caught in bush-path, at 125¼ miles on Gold Coast Government Railway, 11.30 a.m. (*Dr. W. M. Graham*); one other para-type from Ikom Station, Cross River, Southern Nigeria, 6. vi. 1910 (*Dr. W. S. Clark, W.A.M.S.*: presented by the Entomological Research Committee).

Dr. W. M. Graham, in whose honour the new *Subpangonia* is named, has kindly supplied the following field-note.—"The first specimen of this species that I met with I mistook for a humble-bee, on account of its curious habit of hovering in the air and buzzing loudly, darting away for a moment and then returning and buzzing round me again. This individual was caught in an open plantation, by the side of the Sansu trolly line, about a mile outside Obuasi; the second specimen, the behaviour of which was similar to that of the first example, was taken in a bush-path, in dense bush, a mile and a quarter from Obuasi, towards Kumasi. These were the only two specimens seen in seven and a half months."

*Subpangonia grahami* is closely allied to *S. gravoti*, Surcouf, but may be distinguished by the darker coloration of the dorsum of the abdomen, the first three segments of which are dusky tawny instead of ochraceous; by the predominance of blackish or black hair on the dorsal surface of both thorax and abdomen; and by the presence of a band of silvery-white hairs on at least the lateral portions of the hind borders of the second, fourth, fifth, and sixth abdominal segments, these segments, or at any rate their hind borders, in *S. gravoti* being clothed with ochreous hair.

In addition to the para-type of *S. gravoti* mentioned above, the National Collection possesses a female of this species from the vicinity of Edi-Emi, Meko Road, Western Province, Southern Nigeria, 3. vi. 1910 (*Dr. G. M. Gray, W.A.M.S.*; presented by the Entomological Research Committee).

## *TABANINAE.*

### Genus Tabanus, L.

**Tabanus canofasciatus**, sp. n. (fig. 5).

♀.—Length (8 specimens) 11.25 to 14 mm.; width of head 4.4 to 5 mm.; width of front at vertex 0.6 to 0.8 mm.; length of wing 10.5 to 11.6 mm.

*Eyes densely clothed with short, fine, yellowish hair; dorsum of thorax clove-brown, with an olivaceous tinge, moderately shining, and sparsely covered with longish, Naples-yellow hair; first abdominal segment ochraceous-buff, second segment more or less cinnamon-rufous or chestnut, each of first two segments*

Fig. 5.—*Tabanus canofasciatus*, Austen, ♀. × 3.

*with a clove-brown median basal blotch on dorsal surface, dorsum of second segment with a hoary, pollinose, transverse band, resting on hind margin and shaped as shown in fig. 5; third and following abdominal segments shining black, hind margins of tergites of third and fourth segments whitish grey, buff, or cream-buff; wings faintly tinged with drab; tibiae, except distal extremities, cream-buff.*

*Head* dull yellowish-grey pollinose, face, jowls, basi-occipital region, and part of occiput clothed with yellowish hair; *front* of nearly uniform width throughout, about three and a half times as long as broad, clothed mainly with black or mainly with yellowish hair, or else with black hair at lower extremity, at and just below middle, and on ocellar spot, and clothed elsewhere with yellowish hair; *frontal callus* clove-brown, shining, small and inconspicuous, sending off a black, linear, median prolongation towards ocellar spot, which is also clove-brown or blackish; just below middle of front on each side is an ill-defined,

clove-brown or blackish, elongate mark, usually clothed with black hair; *palpi* slate-grey (distal extremity of proximal joint and inner surface of terminal joint greyish cream-buff or drab-grey), clothed with bright yellowish hair (and in case of terminal joint also with some minute black hairs on outer side towards distal extremity), terminal joint small and acuminate; *antennae* greyish clove-brown (last four annuli of terminal joint black), first joint clothed mainly with yellowish hair, third joint narrow and elongate, usual angle on upper margin near base often so little developed as to appear non-existent. *Thorax:* swelling occupying depression at each end of transverse suture usually greyish fawn-coloured; pleurae and pectus grey pollinose, clothed with yellowish hair. *Abdomen:* clove-brown median basal blotches on first two segments shaped as shown in fig. 5; first segment, hoary transverse band on second segment, posterior margins of third and fourth segments, and lateral margins of tergites of second to fifth segments inclusive clothed with yellowish or ochreous hair, hind margin of tergite of fifth segment also with some yellowish or ochreous hairs; hind margins of third and fourth segments somewhat deeper on each side; clove-brown median blotch on second segment clothed with black mingled with yellowish hair, tergites of third and following segments, except as already stated, clothed with black hair; venter agreeing with dorsum in coloration, except that second segment is without the characteristic hoary transverse band seen on dorsum, but has only a much less deep, straight, whitish-grey pollinose hind border, and that hind margin of fifth segment is sometimes more distinctly grey or yellowish-grey than is usually the case on dorsum; hind margin of ventral scute of sixth segment also sometimes narrowly grey. *Wings:* costal cells tinged with raw sienna; *stigma** mummy-brown, elongate, and conspicuous; veins partly mummy-brown, partly dark brown. *Squamae:* thoracic squamae cream-buff, borders buff. *Halteres* ochraceous-buff or buff, stalks somewhat darker. *Legs:* coxae grey, clothed with yellowish hair; femora blackish slate-coloured, upper surfaces, and also anterior surface in case of middle pair clothed with black hair, posterior surface of anterior pair clothed with longer yellowish or longer black hair, or with both, under surface of middle and hind pairs clothed with longer yellowish hair; extreme base of tibiae, at least on upper side, dark brown, distal third of front tibiae clove-brown (this dark area is usually rather more extensive below and on under side than above), extreme tips of middle and hind tibiae dark brown or brownish, pale portion of tibiae clothed with bright, pale straw-yellow hair, which on outer side is sufficiently long to form a more or less conspicuous fringe, denser on the hind tibiae than on the others; front tarsi black or clove-brown, middle and hind tarsi dark brown, usually lighter at base; in case of hind tarsi, first three joints, except tips, and extreme base of two following joints raw-umber-coloured.

East Africa Protectorate: type from Crater Lake, North of Mt. Kenia, 15.ii.1911, "on mule" (*S. A. Neave:* presented by the Entomological Research Committee). Para-types as follows (all collected by *Mr. S. A. Neave*, and—with the exception of one specimen retained by the Committee—presented

* Not shown with sufficient clearness in the figure.

to the National Collection by the Entomological Research Committee): two specimens from the south-east slopes of Mt. Kenia, alt. 6,000 to 7,000 ft., 3–12.ii.1911; one specimen from the southern slopes of Mt. Kenia, 6.ii. 1911; one specimen from Meru (north of Mt. Kenia), 14.ii.1911; three specimens (one "biting native") from the eastern foot and slopes of the Aberdare Mts., alt. 7,000 to 8,500 ft., 24–27.ii.1911.

*Tabanus canofasciatus* is distinguished from *T. ruwenzorii*, Ric.,—another hairy-eyed species to which it is closely allied and to which it presents a strong resemblance in general appearance,—*inter alia* by the colour of the hairs clothing the terminal joint of the palpi, which are black in the case of *T. ruwenzorii*, and by the presence of the hoary, pollinose, transverse band on the second abdominal segment, this band being completely absent in *T. ruwenzorii.*

It is worthy of remark that both species—which, owing to their eyes being hairy, belong to the "subgenus" *Therioplectes*, now no longer recognised—are *mountain* forms, the type and para-type of *T. ruwenzorii*, which are the only specimens of this species at present known, having been obtained at an altitude of between 5,000 and 13,000 ft., in East Ruwenzori, Uganda Protectorate.*

**Tabanus tenuipalpis,** sp. n. (fig. 6).

♀.—Length (2 specimens) 17·2 to 17·5 mm.; width of head 5·75 to 6·25 mm.; width of front at vertex 0·5 mm.; length of wing 15·75 to 16 mm.

*Dark brown species (dorsum of thorax—except scutellum, which is paler—sepia-coloured), with exceedingly narrow front, and remarkably slender palpi; dorsum of*

Fig. 6.—*Tabanus tenuipalpis*, Austen, ♀. × 2¼.

*abdomen with whitish markings, as shown in fig. 6; wings strongly tinged with sepia, especially about fork of third vein and along hind border.*

*Head:* subcallus, face, jowls, and basioccipital region light grey or yellowish-grey, occiput grey; face and jowls sparsely clothed with short, fine, blackish hairs, basioccipital region clothed with longer whitish hair; *front* grey (appearing dark brown, except on each side of callus, when viewed at certain angles), narrowing from above downwards and (estimated by eye) about nine or ten times

* [Two additional specimens (both females) have recently been taken in Ankole, Uganda, by Dr. R. E. McConnell.—Ed.]

as long as its breadth at lower extremity ; *frontal callus* mummy-brown, acicular or lanceolate, its upper extremity produced into a median ridge ; *palpi* isabella-coloured, drab, or greyish-fawn-coloured, proximal joint clothed below with whitish hair of moderate length, terminal joint unusually slender, tapering to a point and clothed on outer side with minute blackish hairs ; first and second joints of *antennae* greyish cinnamon, clothed with black hairs, third joint clove-brown, expanded portion of moderate breadth. *Thorax:* dorsum of main portion without distinct markings, and clothed with minute, appressed, dark brown hairs ; swelling in depression at each end of transverse suture isabella-coloured, and clothed above with yellowish hair ; humeral and postalar calli and lateral border of dorsum above base of wing on each side greyish cream-buff ; postalar calli each with a conspicuous tuft of longish white hair on outer margin ; a small tuft of similar but shorter hair above base of each wing ; pectus and pleurae pinkish buff or greyish cream-buff, clothed partly with whitish, partly with dark brown or brownish hair ; dorsal surface of scutellum clothed with appressed, glistening, light-coloured hair, which is for most part yellowish, but is whitish on lateral margins and deeper in colour in centre and towards front. *Abdomen :* posterior angles of tergites of all except last two segments light grey, and clothed with shining silvery-white hair ; tergites of second to fifth segments inclusive each with a light grey spot, more or less semi-circular in outline and clothed with short, appressed, glistening white hair, on hind border in median line ; tergite of first segment with a few yellowish hairs on and near hind margin, in median line ; dorsum, except as stated, clothed mainly with short, appressed, dark brown hairs, though the hairs immediately in front of each median spot are more or less yellowish ; the grey ground-colour of the posterior angles of the tergites of the second to the fifth segments inclusive extends inwards to some extent, but does not reach the median spots ; ventral surface dark brown and clothed with minute appressed hairs of same colour, hind borders of second to fifth segments inclusive light grey, and clothed with short, appressed, silvery-white hair. *Wings :* costal cells raw-sienna-coloured ; infuscation at tip of wing may take shape of a border on each side of anterior branch of third longitudinal vein and of distal portion of second longitudinal ; infuscation along hind border occupies second and third posterior cells, fourth posterior cell except immediately adjacent to discal cell, and distal halves of first and fifth posterior cells, and dies away in distal extremity of axillary cell ; veins or portions of veins forming distal boundary of basal cells somewhat infuscated ; veins mummy-brown or dark brown ; *stigma* mummy-brown, narrow, and elongate. *Squamae* sepia-coloured, borders darker. *Halteres* dark mummy-brown, tips of knobs sometimes paler. *Legs :* coxae greyish, clothed with dark brown hair, front pair with greyish hair at base anteriorly ; femora and hind tibiae dark brown, clothed with similarly coloured hair ; front tibiae sepia-coloured at extreme base, then cream-coloured, except distal third or rather less, which is dark brown ; cream-coloured portion of front tibiae clothed anteriorly with minute black or dark brown hairs, which however may be more or less interspersed with or replaced by minute, glistening, cream-coloured hairs ; middle tibiae dark mummy-brown, dark brown at distal extremity ; front tarsi clove-brown, not expanded, middle and hind tarsi dark brown.

Gold Coast (Colony and Protectorate), and Sierra Leone Protectorate: type from Obuasi, Ashanti, 10. xii. 1907, "caught on wall of veranda at 4 p.m., after rain" (*Dr. W. M. Graham, W.A.M.S.*); a second specimen (para-type) from the Tano River, ten miles north of Half Assinie, 25–30. i. 1910 (*W. Van Eeden*); a third female from Daru, Sierra Leone Protectorate, 2. viii. 1911 (*Dr. J. C. Murphy, W.A.M.S.*: presented to the British Museum by the Entomological Research Committee).

The species described above is allied to *Tabanus obscurefumatus*, Surcouf, which was originally obtained in Spanish Guinea, and is represented in the British Museum collection by a number of female specimens from Southern Nigeria. While resembling *Tabanus tenuipalpis* in the narrowness of its front and frontal callus, in the peculiarly slender shape of the last joint of its palpi, and in its abdominal markings, the female of *T. obscurefumatus* is distinguished from that of the new species *inter alia* by the front being actually slightly narrower, by the terminal joint of the palpi being slate-grey or slate-coloured instead of as described above, by the slate-black colour of its abdomen, and by its legs, except the proximal portion of the front tibiae, being black.

**Tabanus barclayi**, sp. n.

♀.—Length (16 specimens) 11·25 to 14 mm.; width of head 3·4 to 4·2 mm.; width of front at vertex 0·6 to 0·75 mm.; length of wing 9·6 to 11·8 mm.

*Smallish or small, somewhat narrow-bodied, elongate species, with relatively rather broad front, which is often wider below, and abdomen tapering slightly towards distal extremity; dorsum of thorax greyish sepia-coloured, longitudinally striped with grey; dorsum of abdomen sepia-coloured or mummy-brown, with narrow, smoke-grey, median longitudinal stripe, and a much broader, drab-grey or yellowish-grey, longitudinal stripe on each side of this, between median stripe and lateral margin.*

*Head*: subcallus, face, jowls, and basi-occipital region whitish-grey pollinose, occiput smoke-grey; face, jowls, and basi-occipital region clothed with whitish or white hair; *front* yellowish-grey pollinose (its upper portion clothed with minute, blackish hairs), often distinctly wider at lower than at upper extremity, but if not, then inner margins of eyes bordering front parallel; *frontal callus* large, shining dark brown, narrowly separated from eye on each side, its lower margin straight, its upper margin angulate, and produced into an elongate, more or less oval or ovate upper callus; *palpi* cream-coloured, proximal joint clothed below with whitish or white hair, terminal joint moderately or but little swollen at base, clothed on outer side with minute black hairs, mixed with minute, glistening, cream-coloured hairs; first and second joints of *antennae* greyish-buff, clothed with minute black hairs, third joint ochraceous-buff or cinnamon, annulate portion, which is fairly long, darker (brownish or dark brown). *Thorax*: dorsum with three grey, longitudinal stripes commencing on front margin, median stripe very narrow and scarcely extending beyond level of transverse suture, admedian stripes broader and entire; lateral borders of dorsum also grey; pleurae and pectus light smoke-grey pollinose, clothed with whitish hair. *Abdomen*: grey stripes on dorsum complete, or extending from base at least as far as penultimate

segment, the broad grey stripe between the admedian dark stripe and the dark lateral margin on each side consisting of a continuous series of oblong blotches, one on each segment, the inner margin of each blotch being roughly parallel to the lateral margin of the segment, while the outer margin of each blotch runs obliquely backwards and outwards ; hind margins of dorsal scutes of second and following abdominal segments often narrowly grey ; dark stripes on dorsum clothed with minute, appressed, blackish or black hairs, grey stripes clothed with similar yellowish hairs ; lateral borders of dorsal scutes of all segments except last two light smoke-grey pollinose (invisible from above in case of dried specimens) ; venter light smoke-grey pollinose, clothed, except in case of last segment, with minute, appressed, yellowish hairs, ventral scutes of first four segments more or less fawn-coloured, hind borders of second to sixth segments inclusive cream-buff. *Wings* faintly tinged with drab ; veins mummy-brown ; *stigma* mummy-brown, elongate, and often conspicuous. *Squamae* isabella-coloured, borders cream-buff or fawn-coloured. *Halteres* (in dried specimens often appearing pinkish or fawn-coloured): knobs yellowish cream-coloured, stalks ochraceous-buff. *Legs:* femora lighter or darker grey, clothed with whitish hair, their distal extremities or extreme tips buff or ochraceous-buff ; tibiae buff or ochraceous-buff, tips of front pair dark brown ; front tarsi clove-brown or dark brown, not expanded, middle and hind tarsi ochraceous or ochraceous-buff, tips of joints dark brown, last joint of hind tarsi often entirely dark brown.

NYASALAND PROTECTORATE: type and four other specimens (para-types) from Fort Johnston, South Nyasa, 26. ii. 1910, "taken in goat-kraal" (*Dr. A. H. Barclay*); four specimens from the Shire River, alt. 2,000 ft., 1, 3, 25. iii. 1910, and two other specimens from Fort Johnston, 24. iii. 1910 (*Dr. A. H. Barclay*); one specimen from Kambiri, Central Angoniland, near Lake Nyasa, 28. i. 1910, and two specimens from the vicinity of the Livelezi River, South Nyasa, 3. ii. 1910 (*Dr. J. B. Davey*) ; two specimens from Zomba District, 1909 (*Dr. S. K. Norris*) :—all except the last two presented to the British Museum (Natural History) by the Entomological Research Committee.

In addition to the foregoing, the following in the possession of the Committee have also been examined ; seven specimens taken by *Dr. Barclay* between 26. ii. and 24 iii. 1910, at the localities already mentioned ; two specimens taken by *Dr. J. B. Davey*, 2. ii. 1910, at the locality mentioned above ; one specimen from Fort Johnston, February, 1910 (*S. A. Neave*) ; and one specimen from Liwonde, 20. i. 1911 (*Dr. J. E. S. Old*).

The species described above, which has been named in honour of one of its discoverers and is apparently common in South Nyasa in February and March, is allied to *Tabanus pallidifacies*, Surcouf, which is at present known only from the East Africa Protectorate. *Tabanus barclayi*, which resembles *T. pallidifacies* in the width of its front and the shape of its frontal callus, may however be distinguished from the species mentioned by the narrower shape of its body, by the front being if anything wider below than above (instead of the reverse), and by its abdominal markings,—the greyish longitudinal stripe on the dorsum between the median stripe and each lateral margin not being broken up into a series of oblique spots.

## Genus Hippocentrum, Austen.

**Hippocentrum murphyi,** sp. n. (fig. 7.)

♀.—Length (2 specimens) 11·5 to 12 mm.; width of head 3·75 mm.; width of front at vertex just over 1 mm.; length of wing 11 mm.

*Black or clove-brown; median portion of face dark mouse-grey pollinose; terminal joint of palpi narrower, more elongate, and less shining on outer side than in* H. trimaculatum, *Newstead, or* H. versicolor, *Austen; wings dark sepia-coloured, with (at least in type and para-type) only the faintest possible (scarcely discernible) vestiges of light markings, proximal portion of wings paler; legs black, proximal third of front and hind tibiae, rather less than proximal half of middle tibiae, and first joint of middle and hind tarsi except distal third cream-coloured.*


Fig. 7.—*Hippocentrum murphyi*, Austen, ♀. × 4; *a*, head in profile, to show shape of terminal joint of palpi.

*Head:* front shining black, with a pair of oblique depressions, which are divergent below and meet inner margins of eyes, enclosing between them an elevated area which is roughly triangular in outline and has its blunt apex directed upwards; a dull black spot between bases of antennae; sides of face shining black; occiput dull slate-grey; *palpi* clove-brown, blackish at tips and clothed on outer side with blackish hair, terminal joint elongate, flattened on outer side on rather less than basal half and only moderately shining; first joint of *antennae* burnt-umber-coloured, clothed with blackish hair, moderately stout and of uniform thickness except at extreme base, second and third joints clove-brown, last three annuli of third joint sometimes appearing darker than expanded portion. *Thorax:* dorsum blackish clove-brown, greyish pollinose in front, area immediately above base of each wing paler; pleurae and pectus slate-grey, thinly clothed with whitish hair. *Abdomen:* dorsum clove-brown, first three segments sometimes paler, second and third segments narrowly grey at extreme base; hairy covering of dorsum black, short and appressed on second and four

following segments, somewhat longer and more erect on first and last segments; ventral scute of second segment more or less mummy-brown proximally, clove-brown or dark sepia-coloured distally; ventral scutes of third and fourth segments lighter or darker clove-brown, base of ventral scute of third segment sometimes more or less mummy-brown; ventral scutes of last three segments clove-brown or black; hind borders of ventral scutes of second and two following segments light grey pollinose, and clothed with minute, appressed silvery-white hairs; ventral scutes of last three segments clothed with short black hair, hind margins of fifth and sixth segments narrowly greyish. *Wings:* stigma large, elongate, very dark brown and conspicuous; first and second costal cells mummy-brown; basal cells, proximal two-thirds of anal cell, and base of axillary cell dusky hyaline, distinctly paler than distal half of wings; proximal portion of marginal cell, as far as commencement of stigma, semi-hyaline; first submarginal and first posterior cells with a faintly indicated narrow pale transverse mark running across the base of each; a similar mark resting on the anterior side of the third longitudinal vein, a little before the backwardly directed appendix to its anterior branch, and a third minute pale mark in the discal cell near its distal extremity, resting on the fourth vein; these marks are more distinct in the para-type than in the specimen selected as the type. *Squamae* dark sepia-coloured. *Halteres:* knobs buff-yellow or buff, stalks brownish, buff-yellow or buff at the tips. *Legs:* front tibiae conspicuously incrassate; black portions of legs clothed with black hair, cream-coloured proximal portions of tibiae clothed with minute, appressed, silvery-white hairs, some of which, at least on the inner or posterior surfaces, are also to be seen on the proximal extremities of the black parts of the tibiae.

Sierra Leone Protectorate: Gondema (about 10 miles north of Barriwalla, close to Anglo-Liberian Frontier), 15.vii.1911, "not numerous" (*Dr. J. C. Murphy, W.A.M.S.:* presented by the Entomological Research Committee).

This fine species is named in honour of its discoverer, who, by his energy as a collector, has during the past few years done much to extend our knowledge of the blood-sucking flies of the hinterland of Sierra Leone. Owing to its size alone, *Hippocentrum murphyi* is readily distinguishable from the other species of its genus at present known, while as regards *H. versicolor*, Austen, further distinctive characters are afforded by the palpi (*see* diagnosis above), the practically unicolorous wings, the sharply contrasted colours of the conspicuously banded legs, and the swollen front tibiae. From *Hippocentrum trimaculatum*, Newst., which is perhaps identical with *H.* (*Haematopota*) *strigipennis*, Karsch, *H. murphyi*, apart from its size, is distinguished by the palpal character already mentioned, the greater thickness of the first joint of the antennae, the absence of more or less conspicuous wing-markings, and the coloration and banding of the legs.

# ENTOMOLOGICAL RESEARCH IN BRITISH WEST AFRICA.

## III.—SOUTHERN NIGERIA.

By Jas. J. Simpson, M.A., D.Sc.

(*With a Map showing the distribution of* Glossina *and photographs by the author.*)

(Plates II—V.)

Contents.



### Introductory.

The Colony of Southern Nigeria was traversed by the writer in 1910, and the following short report is founded on observations made during the first seven months of that year. As will be seen later on, various officers, chiefly medical, stationed in the Colony, afforded material help in the investigation, and the results of their work are also incorporated here; the collections of injurious insects made by them have been duly acknowledged in previous issues of this Bulletin, and also, as far as possible, throughout this report.

A word of explanation is necessary in order to avoid any misapprehension of the aims of the writer in framing this résumé. The report deals entirely with the blood-sucking insects and other arthropods which are or may be associated with the various parasitic diseases found in this and similar Colonies. As in the case of all Tropical African dependencies, prior to the formation of the Entomological Research Committee, very little was known of the economic entomological fauna. Through the instrumentality of the Medical Research Institute at Yaba (five miles from Lagos), Southern Nigeria is probably ahead of most other Colonies in this respect. Considerable work has been done there, chiefly on mosquito larvae, but this work has been confined almost entirely to Yaba and Lagos, a very circumscribed area.

The primary aim of the Entomological Research Committee, so far as Tropical Africa is concerned, may be tersely summed up as "a complete study of the insects and other arthropods implicated in the transmission of diseases in man and other animals."

Unfortunately, at present, it is not possible to detail with certainty, except in a few special cases, which diseases are insect-borne and which are not. Further, although certain insects have been proved to be the carriers of particular diseases, it is far from certain that other allied species may not also be implicated. For example, it is now known that *Glossina palpalis* and *G. morsitans* transmit sleeping sickness from man to man, yet it is not possible to say whether only these species of *Glossina* or only this genus may be capable of transmitting it. Again, in the case of malaria, we know that this disease is transmitted by Anopheline mosquitos, but of these there are many species, and, with the exception of a very few, no definite statement can be made as to which are or are not innocuous. A third example is yellow fever. It is well known that *Stegomyia fasciata* transmits this disease, but as to whether this is the only species capable of such transmission no one will at present venture to say. Another disease, unfortunately by no means uncommon in Southern Nigeria, is "Calabar swelling"—but of the etiology of this malady practically nothing is known beyond the fact that it is probably insect-borne. The same may be said of elephantiasis; and doubtless there are other maladies which, though at present not thus associated, may eventually prove to be disseminated by insects.

Enough has been said to emphasise the necessity for much experimental work, and it is towards the stimulation of an interest in the entomological aspect of such investigations that the efforts of this Committee are mainly directed.

The first step in such an enquiry must naturally be a mapping out of the various endemic centres of the different diseases, combined with a similar study of the distribution of the various blood-sucking insects. Always remembering that every blood-sucking arthropod is, so far as we know, a potential disease-carrier, one must carefully record the distribution of each and every species. When this has been done, it is more than probable that such maps, when superimposed, may give valuable clues as to the inter-relationship of certain diseases with certain species of insects. This then is one of the first problems to be solved.

Our ignorance of such distribution is not due to any lack of interest or desire on the part of the various officials, but in most cases to a lack of material for collecting and preserving, or to the difficulty of obtaining identifications of unfamiliar species when collections have been made. Such collecting should always involve the recording of observations, such as the nature of the habitat, *e.g.*,whether the species is found in the open, associated with bush, in houses, near water, etc., the season of the year, the weather conditions, the time of the day, and so on. An endeavour should also be made to ascertain the breeding-places, the different immature stages, and the nature of the food supply, in fact, everything which is essential or detrimental to the existence of the various species. This will form the basis for prophylactic measures and will also help to indicate along what lines insect-borne diseases may be expected to spread, and so be a means of preventing any extension of the endemic areas.

It is obviously useless for any one to carry on transmission experiments, to dissect for parasites or such-like, unless he is perfectly certain of the species with which he is dealing, so that the second step in this work is identification.

From what has been said, it will be seen that such investigations can be effected only by those stationed for a considerable time in one place, and further, that it is important that these observations should be made at as many places as possible and continuously throughout the different seasons. Consequently, it has been the aim of the Committee to stimulate interest in this work and to help to overcome the difficulties which confronted many who had previously directed considerable attention to this subject.

Instructions and apparatus for collecting were distributed to the various stations; collections made in these districts were identified and the names of the various species sent to the different collectors, along with named specimens where desired, so that it is hoped that eventually in each station there will be a named collection of all the economic insects found in the district. The Bulletin serves as a medium for recording observations, and any notes or papers, however short, bearing on any aspect of economic entomology are published therein.

A proof of the results of the endeavours of the Committee in this work may be gathered from the number of volunteer workers whose names occur in previous issues of the Bulletin and in this report, and it must be remembered that this work is carried on in spare time after multifarious and ardous duties, often under very trying conditions, and consequently reflects the greatest credit on those men who are thus labouring in the interests of humanity. It is hoped, however, that many who at present are accumulating important observations will give the results of their work more concrete form, in short papers, for the benefit of others interested.

The main object of the writer in order to further this investigation in Southern Nigeria was, therefore, to make as extended a tour as possible, visit the various stations, and so come in contact with those already interested in such work, or, by explaining the aims and methods of the Committee, to secure the co-operation of those who might be persuaded to aid in the scheme. Consequently, it was impossible for the writer to do any actual experimental work or devote any time to the study of life-histories or such-like investigations in any special locality.

The report must, therefore, be considered as a general geographical survey, and taken with other notes and papers published dealing with Southern Nigeria, forms a résumé of recent work. Further, it is hoped that it may serve to show not how much, but how little, is known of this aspect of the subject. Considerable collecting was done, and these records are incorporated along with those of other officials who have from time to time sent specimens from different localities. The arrangement followed is, to a certain extent, different from that adopted in my previous reports on the Gambia * and Northern Nigeria.† I have altogether disregarded the order in which the various parts of the colony were visited, and have considered the region from a general geographical aspect. The route followed is, however, shown on the map which accompanies the report.

The greatest stress has been laid on the factors which influence the distribution of the various species of blood-sucking insects, and in this connection the general

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* Bull. Ent. Res. II, pt. 3, pp. 187–239. † Bull. Ent. Res. II, pt. 4, pp. 301–356.

geographical situation of the colony, the main topographical features, the river and mountain systems, the climate and rainfall, and the various types of vegetation and their distribution, have received consideration.

A short description of the main characteristics of the regions I was unable to visit have also been given, so that when records from these localities come to hand it may be possible to correlate them with others already known as to similarity of environment, climate, etc.

A map has been prepared to show the distribution of the various species of *Glossina* in the colony, and on it are included all available authentic records. A short chapter has also been added emphasising the main features of this distribution.

A list of all the blood-sucking insects, and other arthropods has been drawn up, and though this list is already large, there is little doubt that further work will still augment the number. At the same time, in the case of many of the species, little is known of their general distribution.

A few notes on the different protozoal diseases found in the colony are also given, but our knowledge of the distribution or endemicity of these is far from complete, while, in this connection also, a résumé of what is known of the prevalence of the various species of *Stegomyia* has been added.

In my previous reports I have discussed at some length a few of the many problems which require further investigation, and, as these are equally applicable to Southern Nigeria, there is no necessity for reiterating them. The same holds good with regard to remedial measures and recommendations, so that, with the exception of a few special cases, these have also been excluded from this report.

Sufficient has been said, therefore, to indicate the lines along which this report was possible and on which it has been framed, but I would once more like to point out that, although it was impossible for the writer to attempt to solve any particular problem, it is hoped that this account of the work done, and its general bearing on distribution, may help to stimulate others to an elucidation of the important bearing of insects in their relation to disease, and indicate lines along which such work may be most profitably accomplished. At the same time it may help to show how such difficulties as the identification of insects may be overcome, and also how the most trivial observations may be utilised in the general scheme of knowledge.

## I. Geography of the Colony and Protectorate.

### (*a*) Position and Extent.

The Colony and Protectorate of Southern Nigeria, one of the oldest and most productive of the British West African Possessions, is situated in the extreme east of the Gulf of Guinea. Its total area is estimated at about 77,500 square miles, or nearly two-thirds of the United Kingdom. Owing to its irregularity in shape, its extreme limits are separated by great distances, *e.g.*, its eastern and western boundaries lie approximately in 10° 15′ E. and 2° 15′ E., while the northern and the southern limits are in 9° 10′ N. and 4° 20′ N. respectively. Its

total native population is between 6,500,000 and 7,000,000, and there are over 1,500 Europeans in the Colony.

Formerly this area was divided politically into the Colony of Lagos and the Protectorate of Southern Nigeria, each with its own administration, but recently the two have been amalgamated into the "Colony and Protectorate of Southern Nigeria" as a single dependency.

Roughly speaking the old Colony of Lagos is now known as the Western Province, and the old Protectorate is subdivided into two Provinces, the Central and the Eastern (*see* Map). The term "Colony" will be used to denote the whole area, and the subdivisions will be referred to as the Western, the Central, and the Eastern Provinces respectively.

Lagos, an important and flourishing seaport, is the seat of administration of the Colony and also the headquarters of the Western Province, while Warri and Calabar are respectively the headquarters of the Central and the Eastern Provinces. At these three towns are stationed the Provincial Heads of Departments, and here also are situated the three European Hospitals.

The division of the Colony into three Provinces is to a certain degree arbitrary, but to a great extent these form fairly definite geographical areas. As will be seen later, the Western Province has no large rivers but is traversed by the Lagos Railway, which now unites Lagos with Zungeru, Kano and the Bauchi tin mines in Northern Nigeria; the Central Province is traversed by the River Niger, the main outlet to the sea for exports from both Northern and Southern Nigeria; and the Eastern Province is drained by the Cross River, which, during the rainy season, is navigable throughout its entire course in Southern Nigeria and even into the German Colony of Kamerun.

Lagos is by far the most important town on the coast, and now that Northern Nigeria has been linked up by means of the railway, a considerable amount of the passenger and light goods traffic which formerly went by way of the Niger will pass through this port. At the present time, owing to the dangerous nature of the bar, mail-steamers are unable to enter the harbour, and all heavy cargo is trans-shipped at Forcados into smaller "branch boats" and then transferred to Lagos, but harbour works are being rapidly carried out, on the completion of which it is hoped that the mail-boats will load and unload direct at Lagos.

The port-of-call for mail-steamers in the Central Province is Forcados, which is undoubtedly the largest shipping port in West Africa. This port must always be the main outlet for exports from a large part of Northern Nigeria, and at the same time, as the headquarters of the Niger Company, it will continue to be the chief port of shipment for the produce of Southern Nigeria. Such being the case, special attention should be directed to it and special efforts made to ensure that the conditions there are such that there could be no possibility of any insect-borne disease obtaining a hold and spreading, even if introduced.

There are two ports in the Eastern Province, namely, Bonny and Calabar, but the latter is by far the more important, and, as in the case of Lagos and Forcados, they must also be regarded as possible centres for the dissemination of disease.

These ports, however, are only the foci of the trade of the Colony, so that it is necessary to go further afield and consider the routes along which this trade comes, the potentiality of these various regions as regards diseases transmitted by insects, and the distribution of the insects implicated. The major features of the geography of the Colony, so far as they concern the investigation in hand, have been briefly dealt with in the various sections of the report, so that it is unnecessary to enter into any discussion of them at this point.

**(*b*) Physical Configuration.**

The trade of Southern Nigeria has always been intimately associated with the River Niger and its delta, and consequently, not until very recently have the parts of the country removed from this river been traversed by Europeans. The construction of the Government Railway served to open up the Western Province, and within the last few years large tracts of country, particularly in the north-east, have been gradually brought under European influence. This region is known as the Munchi country and is inhabited by a very truculent and vindictive tribe of that name. Consequently our knowledge of the physical characteristics of Southern Nigeria is very limited, but an exhaustive survey of the whole Colony is rapidly progressing. It might be well, however, to note a few of the leading topographical features in so far as they are likely to influence the distribution of the fauna.

There are three distinct river systems in Southern Nigeria and these roughly correspond with the three Provinces :—the Cross River in the Eastern Province, the Niger in the Central Province, and a number of small rivers, the largest of which is the Ogun, in the Western Province.

There are no mountain ranges of any great height in the Colony, the highest being the watershed between the Niger and Cross Rivers, in what is known as the Sonkwala Country, which has only recently been opened up. This range consists of several peaks rising from an extensive plateau, the height of which has been variously estimated, but which, in all probability, does not exceed 4000–5000 feet. Next in importance are the Oban Hills, which lie to the east of the Cross River and form the watershed between it and the Kwa River. The various peaks in this small range are very imperfectly known, but average about 3000–3500 feet in height. The lofty Kameruns in the German Colony of that name constitute the main catchment area for the Cross River and are the only large mountain range on this part of the coast.

In the Ondo district are the Idanre Hills, which consist of several peaks of about 3,000 feet in height. These form the watershed separating the Niger basin in the Central Province from the system of small rivers in the Western Province. Almost continuous with these are the Efon Hills in the Ilesha District ; they run nearly east and west and send their waters on the northern side to the Niger in Northern Nigeria, and their southern waters to the rivers in the Western Province of Southern Nigeria. Of less importance are the Shaki Hills in the north-west and the Tapa Hills between the rivers Awon and Afiki, both tributaries of the Ogun.

As has been shown, the only rivers of any size in the Colony are the Niger and Cross Rivers, but neither of these is dependent on the rainfall of Southern Nigeria to any great extent. The rise of the Cross River is due almost entirely to the heavy rainfall in the German Kamerun hinterland, while that of the Niger is associated with the increased supply from its higher reaches in French Guinea and Northern Nigeria and also from the Benue River. The Benue in turn receives its supply from the Kamerun hinterland. The heavy rainfall of Southern Nigeria is confined practically to the Coast, or delta region, and is consequently almost coterminous with the area of tidal influence.

Generally speaking, the whole of the shore area is low-lying and fringed with mangrove swamp. It consists of a large alluvial plain which extends for hundreds of miles, except on the extreme east, where the Oban Hills almost touch the foreshore and extend northwards to the Kameruns. This alluvial low-lying land reaches its greatest dimensions in the delta of the Niger, which projects so far into the Gulf of Guinea as to form two distinct bays known as the Bights of Benin and Biafra.

Beyond this zone the land gradually rises, and the mangrove gives way to the open grassy plains of the hinterland, which extend to Northern Nigeria. Superimposed on these are the various small mountain ranges already mentioned, which separate the different drainage systems.

The soil is mainly red clay, but the hills are intrusions of metamorphic rocks, granitoid, schistose or quartzite. Here and there beds of limestone occur, and, more commonly, large outcrops of laterite.

### (*c*) Vegetation.

As has been shown in my previous reports, the nature of the vegetation in any part of a colony has a distinct bearing on the insect fauna. For this reason it might be well to discuss briefly the main types found in Southern Nigeria, their general character, and their distribution. I am indebted to an admirable paper* by Mr. H. N. Thomson, Conservator of Forests in Southern Nigeria, for a considerable part of what follows in this chapter. The quotations given are taken from that report.

The type of forest found in any particular region depends almost entirely on the rainfall, but occasionally in the drier regions one comes across patches of a type generally associated with a heavy rainfall ; these occur as outcrops due to permanent and abundant telluric moisture.

The forest growths of Southern Nigeria may be divided roughly into :—(*a*) tropical rain forest, (*b*) fresh-water swamp forest, (*c*) monsoon or mixed deciduous forest, (*d*) savannah forest and (*e*) mangrove forest.

Generally speaking, where there is an abundant supply of moisture and little or no differentiation into wet and dry seasons, the tropical rain forest predominates ; where the soil is permanently moist, even if there is a moderately long dry

* Journ. Afr. Soc. X, p. 125.

season, fresh-water swamp forest is to be found ; where the soil is more porous, and where there are distinct wet and dry seasons, monsoon forest is in evidence ; where the dry season is of still longer duration, the water supply very limited and precarious, and the soil is of a light character, the savannah type is prevalent : while in the river deltas and lagoon, where the tidal influence is felt and the water is brackish, mangrove thicket is everywhere to be found. The distribution of these types in Southern Nigeria can be indicated only in a very general way.

*Rain forest* may be said to occupy all the areas with an annual rainfall of about 76 inches and upwards, but exists in its most typical form in those regions where there is a rainfall of 100 inches and over, and where the dry season is of extremely short duration or almost entirely absent. These conditions are satisfied to a greater or less extent around Ilesha, Ondo and Ijebu-Ode in the Western Province, in the west and south-west portions of the Benin District in the Central Province, and on the slopes of the Oban Hills and other high ranges in the Eastern Province.

"It is generally assumed that the moist portions of Southern Nigeria are very densely wooded and that the bulk of the land is covered with high rain forest. This, however, is far from being in accordance with the truth, and the mistake has in most cases arisen from the fact that the main native paths and roads are fringed on both sides with broad belts of high forest purposely left intact by the inhabitants . . . The country is literally honeycombed with farms and their overgrown abandoned sites."

Scattered throughout the Colony are many swampy areas and rocky hillsides impracticable for farming, and these have consequently been left intact and bear dense high forests. With the exception of these areas the greater part of the country, lying within the zone of rainfall mentioned, is covered with a secondary growth of a much drier character and considerably less dense than the untouched virgin rain forest.

*Fresh water swamp forests* are composed of plants that have become adapted to growth in permanently wet soil. They correspond to the kurimis of Northern Nigeria, which I have already described at some length.* No general idea of the distribution of this type can be given beyond pointing out that they occur chiefly along the banks of rivers and streams or are scattered irregularly amongst other formations in places where there is permanent telluric moisture.

*The monsoon or mixed deciduous forests* contain, as the name indicates, many trees which become leafless in the dry season. They are less lofty than the rain forests and not so dense. Lianes and herbaceous epiphytes are abundant, and the contrast in appearance during the wet and dry seasons is very marked.

"As regards the distribution of the monsoon forests they are confined to those tracts of country where the available water supply and the duration of the dry season operate jointly in such a manner as, on the one hand, to exclude the

* Bull. Ent. Res. II, pt. 4, p. 307.

tropical rain forest and, on the other, so far to favour tree-growth that a woodland formation can still successfully compete against grass forms such as savannah forests. Such conditions are realised in Southern Nigeria along an irregular, tortuous, comparatively narrow belt that lies, roughly speaking, between the 7th and 8th parallels in the Western Province, and between the 6th and 7th in the Central and Eastern Province. This belt is pushed far up north in the extreme north-east portion of the Western Province where numerous hill ranges carry a copious rainfall well into the comparatively dry interior."

*Savannah forest* is variously described as "park-like" or "orchard-like," and consists chiefly of tall grasses with numerous terrestrial herbs and a few deciduous trees, which are, on an average, less tall than in the mixed deciduous forest. The number of trees varies in different places according to the nature of the soil and the general situation, *e.g.*, on laterite outcrops they are few in number and stunted, while in valleys they are more numerous and healthy. These areas are generally devastated by huge forest fires towards the end of the dry season, and this tends to reduce them from the savannah-forest type to the pure savannah, where trees are practically absent, and where grass tends more and more to predominate over the terrestrial shrubs.

*Mangrove thickets* are everywhere to be found along the coast, in the various lagoons and backwaters, and in the innumerable creeks and rivers in the delta of the Niger. This type of growth is associated with brackish water and muddy swamp, and is exclusive in character, permitting no intrusion of other trees.

These are the main types of vegetation in Southern Nigeria, and without entering into details at present, that being reserved for fuller discussion under the various regions, it might be well to point out in a general way how these different types are associated with the distribution of the various species of *Glossina*.

*G. palpalis* is to be found everywhere in the mangrove thicket area, and it is especially noteworthy that in such regions the specimens are larger and darker in colour than in other situations. This species is also the predominant one in the rain forest and in the fresh-water swamp forest.

*G. caliginea* seems to be confined almost entirely to the mangrove belt.

*G. longipalpis* is the species most abundant in the mixed deciduous forest region, while in the savannah forest *G. tachinoides* is most likely to be found. As to the other species found in Southern Nigeria, the data available do not justify any definite conclusions being drawn, but the records given throughout the narrative will serve to show how far these species are associated with the different types of vegetation.

## II. Climate and Rainfall.

As is well known, climate and rainfall have a marked bearing on the distribution of the various species of blood-sucking insects, and further, certain species show distinct local modifications which are associated with the comparative lengths of the wet and dry seasons, the range of temperature, and the degree of

humidity. There can be no doubt also that temperature and humidity influence the period of reproduction, and may also modify the length of time occupied in the larval stages.

After a consideration of the general physical configuration of the Colony and its vegetation, it may be well, therefore, to discuss briefly the main characteristics of the climate in so far as these affect the problem in hand. Hitherto, no attempt has been made either to consider the climate of the Colony as a whole or to compare the variations in the different regions. Meteorological observations are now made at a large number of stations in Southern Nigeria, so that it is possible, within limits, to form some general opinion of each of these aspects. The figures on which the following notes are based are compiled from the raw data supplied to the Meteorological Office, but for the arrangement the writer is entirely responsible. It has been considered advisable to prepare and include certain tables in order to avoid lengthy descriptions, and also to present the matter in more concrete form.

The climate of Southern Nigeria is, broadly speaking, of the equatorial type. By this is meant that there are two fairly distinct seasons, known as the "dry" and the "wet" or "rainy" season; the latter is often briefly designated as the "rains." The dry season lasts from about the end of October to the beginning of March, but the rainy season, though, properly speaking, occupying the remaining eight months, is again subdivided into the "heavy" and the "light" rains, each with its own maximum. The heavy rains fall during the months of April, May, June and July, while the light rains occupy the other three months.

A similar state of affairs holds good in the case of the temperature curves, which also have two maxima, the first between the middle of March and the middle of April, and another of a secondary order between the middle of September and the middle of October.

During the heavy rains the weather is for the most part dull, with occasional sunshine, and the humidity is great. Throughout the dry season the weather is clear and fine, but there are occasional showers.

The general direction of the wind is from the south or south-west. The wind is consequently full of moisture, but from the end of November to the beginning of March the influence of the Harmattan—a dry wind blowing from the Sahara in the north-east—is very marked. During this period the air is excessively dry and laden with fine particles of dust; the temperature in the morning and evening is very low, and a misty haze hangs about nearly the whole day. The sun is seldom visible before eight in the morning or after five in the evening, and this haze extends far out to sea. Immediately before and after the rainy season, tornados of terrific force, uprooting large trees and often doing considerable damage, blow in the evenings; these are accompanied by torrential rains.

On the whole, the temperature in the shade is not very high, the average maximum temperature being about 91° Fahr., the average minimum about 65°, the mean about 78°, with a daily range of about 26°. The maximum temperature recorded by the thermometer exposed to the full effect of the sun is about 146°

on the average, whilst the "grass" temperature, that is, the minimum with the thermometer at the ground level, is about 46°.

These are the main characteristics of the climate of Southern Nigeria, but there are enormous differences in the various regions; and as it is with these differences that we are more intimately concerned, it may be well to consider briefly the range of these variations from a geographical aspect.

The following tables have been prepared to illustrate graphically the main features, so that I shall content myself by drawing attention only to the more important characteristics:—

Table A.—Annual rainfall at thirteen stations for the years 1905–1910.

„ B.—Monthly record of rainfall at twenty-two stations for 1909 and 1910.

„ C.—Analysis of the rainfall for 1910, showing on how many days in each month at each station rain actually fell, and also the maximum for any one day in each month at the individual stations.

„ D.—Mean monthly humidity at the various stations in 1910.

„ E.—Analysis of the monthly temperatures for the same stations during 1910.

## Table A.

*Annual Rainfall in Southern Nigeria (in inches).*

| — | Calabar. | Bonny. | Forcados. | Sapele. | Afikpo. | Bende. | Epe. | Lagos. | Onitsha. | Badagri. | Ibadan. | Oshogbo. | Oyo. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1905 | 167·39 | 167·75 | — | 116·25 | 83·88 | 74·67 | — | 65·11 | 60·07 | — | 47·52 | 40·01 | 38·61 |
| 1906 | 156·64 | 142·26 | 98·33 | 106·69 | 93·77 | 87·08 | 60·23 | 74·76 | — | 58·34 | 46·40 | 47·95 | 46·60 |
| 1907 | 129·68 | 143·51 | — | 62·33 | 70·38 | 74·18 | 55·82 | 79·46 | 48·46 | 75·22 | 38·26 | — | 43·81 |
| 1908 | 132·78 | 160·36 | 145·28 | 118·52 | 85·56 | — | 76·93 | 69·98 | 69·88 | 70·02 | 49·48 | 51·43 | — |
| 1909 | 150·24 | 110·78 | 149·25 | 107·72 | — | — | 85·28 | 67·59 | 91·36 | 58·87 | 62·26 | 63·04 | — |
| 1910 | — | — | 114·30 | 105·24 | — | — | 82·09 | 69·43 | 69·62 | 53·06 | 60·00 | — | — |
| Total | 736·73 | 724·66 | 507·16 | 616·75 | 333·59 | 235·93 | 360·35 | 426·33 | 339·39 | 315·51 | 303·92 | 202·43 | 129·02 |
| Mean | 147·34 | 144·93 | 126·79 | 102·79 | 83·39 | 78·64 | 72·07 | 71·05 | 67·87 | 63·10 | 50·65 | 50·60 | 43·00 |

In this table (A) I have selected thirteen stations in which the records for the years 1905–1910 are fairly complete and which are, at the same time, representative of the various parts of the Colony. The mean for these years has been taken as an index of the rainfall of the several stations, which have been arranged in order of descending maxima. The most striking fact revealed by an examination of this table is the enormous range in the mean annual rainfall, for example, 147·34 inches at Calabar, and 43·00 inches at Oyo, while the maximum

recorded since 1905 for any one year was at Calabar in that year, namely, 167·39 inches; at Shaki in the extreme north-west only 17·85 inches fell in 1908.

As has already been pointed out, the coast-line of Southern Nigeria is very irregular in shape, so that it is not possible in all cases to compare places in the same latitude, but, generally speaking, stations on the same parallel of latitude have similar rainfalls; the table also serves to show that the rainfall diminishes from the coast northwards, but not so markedly along the basins of the Niger and Cross Rivers; for example, Lagos 71·08 inches, Ibadan 50·65 inches, Oyo 43·00 inches, and at Shaki the mean for the two years (1907–8) during which observations were recorded, 25·33 inches; or again Calabar 147·34 inches and Afikpo 83·39 inches. Further examination, however, reveals the fact that these means, though very diverse in magnitude, may be grouped according to definite geographical areas thus:—

(1) *Calabar*. The mean annual rainfall at this station, nearly 150 inches, is the highest for the Colony. This station is situated on the Coast in what might be termed the Cross River Delta, and further it is at the base of the Kamerun Mountains.

(2) *Bonny*, *Forcados* and *Sapele*. These three stations have a mean annual rainfall of over 100 inches and may be topographically considered as lying within the Niger delta. In this region it will be seen that the rainfall decreases from the coast inland.

(3) *Afikpo* and *Bende*. The mean annual rainfall in this area is about 80 inches. Both these stations are in the Cross River system, but Afikpo, though further north, has a slightly higher maximum owing to its closer proximity to the basin of the river.

(4) *Epe*, *Lagos*, *Badagri* and *Onitsha*. Lagos, Epe and Badagri are all situated along the coast in the Lagoon region, but Onitsha is on the Niger about 150 miles north of Forcados. Owing, however, to its being actually in the basin of the Niger, its rainfall is greater than its inland situation would otherwise lead one to expect.

(5) *Ibadan*, *Oshogbo* and *Oyo*. These three stations may be grouped together as representative of the hinterland of the Western Province, while a still further reduction in the mean rainfall is seen in the case of Shaki, where in 1908 only 17·85 inches were recorded. Unfortunately, this region is comparatively unknown, and, as no European is now stationed there, no further meteorological observations are available.

Generally speaking, therefore, the greatest rainfall is in the Eastern Province, near the Kamerun Mountains; it is slightly less in the delta of the Niger, while along the Lagoon region and in the basins of the Niger and Cross Rivers there is a still further decrease. The area with the least rainfall is the hinterland of the Western Province. These facts are of some importance in a study of the distribution of the various species of blood-sucking insects.

## Table B.

*Monthly Record of Rainfall in Inches for* 1909 *and* 1910.

### 1909.

| Station. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brass ... | ·40 | 4·81 | 14·10 | 14·89 | 12·44 | 37·16 | 30·05 | 10·22 | 17·35 | 14·78 | 4·71 | 5·06 | 165·97 |
| Calabar ... | ·17 | 5·78 | 9·26 | 7·58 | 9·36 | 17·72 | 33·01 | 26·35 | 28·82 | 5·85 | 5·40 | ·94 | 150·24 |
| Forcados... | 1·55 | 2·45 | 9·45 | 13·50 | 16·10 | 29·20 | 20·50 | 14·50 | 20·60 | 11·80 | 7·00 | 2·60 | 149·25 |
| Akassa ... | 2·61 | 4·68 | 2·28 | 12·34 | 8·51 | 30·28 | 24·02 | 5·55 | 16·56 | 19·09 | 7·89 | 4·27 | 138·08 |
| Bonny ... | 2·50 | 8·67 | 9·84 | 7·30 | 6·32 | 22·14 | 34·68 | 6·09 | 8·08 | 1·91 | 2·67 | ·58 | 110·78 |
| Sapele ... | 1·60 | 3·63 | 7·00 | 16·66 | 15·17 | 14·67 | 18·18 | 13·40 | 9·83 | 4·48 | 2·86 | ·24 | 107·72 |
| Warri ... | 2·11 | 6·61 | 1·81 | 8·42 | 11·16 | 17·40 | 14·15 | 9·39 | 17·19 | 11·45 | 3·87 | ·43 | 103·99 |
| Owerri ... | ·75 | ·99 | 5·07 | 8·06 | 7·92 | 11·56 | 17·03 | 12·84 | 16·23 | 14·13 | ·80 | 2·11 | 97·49 |
| Opobo ... | 1·05 | 4·00 | 2·76 | 3·37 | 8·17 | 17·43 | 19·76 | 6·89 | 18·64 | 2·33 | 5·23 | 2·30 | 91·93 |
| Onitsha ... | ·61 | 1·13 | 6·81 | 6·24 | 6·23 | 8·10 | 21·33 | 11·43 | 14·40 | 7·08 | ·92 | 7·08 | 91·36 |
| Degema ... | ·35 | 4·41 | 7·35 | 4·37 | 8·36 | 11·95 | 25·44 | 8·32 | 6·22 | 7·46 | 2·55 | 1·70 | 88·48 |
| Epe ... | nil | 7·22 | 1·20 | 4·76 | 8·53 | 17·98 | 17·97 | 8·62 | 4·08 | 10·69 | 3·55 | ·68 | 85·28 |
| Abo ... | ·08 | 2·44 | 8·22 | 6·11 | 6·20 | 10·51 | 15·62 | 9·75 | 11·29 | 11·55 | 3·31 | ·19 | 85·27 |
| Benin City | 2·56 | 1·86 | 1·98 | 7·98 | 8·09 | 12·58 | 15·88 | 14·20 | 4·23 | 9·42 | 1·85 | ·35 | 80·98 |
| Olokemeji | 1·03 | 3·16 | 7·71 | 8·97 | 6·40 | 10·30 | 12·36 | 4·69 | 6·09 | 6·76 | 1·42 | 1·54 | 70·43 |
| Ondo ... | 1·02 | 4·05 | 2·47 | 11·57 | 4·72 | 5·26 | 15·26 | 5·94 | 5·24 | 13·45 | — | — | 68·98 |
| Lagos ... | 4·75 | 5·27 | 3·36 | 5·52 | 7·08 | 19·55 | 5·63 | 1·40 | 5·31 | 5·80 | 2·50 | 1·42 | 67·59 |
| Oshogbo ... | ·90 | 3·39 | 2·82 | 6·84 | 3·69 | 8·44 | 11·76 | 6·60 | 8·14 | 8·37 | 1·20 | ·89 | 63·04 |
| Ibadan ... | ·30 | 5·23 | 6·30 | 8·42 | 4·82 | 9·60 | 10·02 | 6·24 | 4·65 | 3·98 | ·52 | 2·18 | 62·26 |
| Badagri ... | 3·92 | 1·03 | 3·25 | 11·93 | 7·14 | 11·20 | 7·62 | 1·36 | 2·88 | 5·62 | 1·15 | 1·77 | 58·87 |
| Abeokuta | nil | 6·50 | 3·67 | 9·51 | 5·29 | 10·33 | 6·33 | 3·67 | 3·82 | 4·98 | 1·22 | 1·94 | 57·26 |
| Otta ... | ·99 | 1·76 | 3·05 | 5·32 | 4·47 | 7·60 | 4·05 | 1·12 | 3·00 | 3·28 | 3·78 | 1·67 | 40·09 |

### 1910.

| Station. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brass ... | ·91 | 4·57 | 7·84 | 6·01 | 7·64 | 21·88 | 19·94 | 11·61 | 25·19 | 19·32 | 12·52 | 4·91 | 142·34 |
| Calabar ... | ·03 | 1·59 | ·89 | 3·52 | 5·87 | 6·89 | 10·58 | 41·24 | 20·77 | 10·73 | — | ·39 | 102·50 |
| Forcados... | ·05 | 3·50 | 2·85 | 7·15 | 17·70 | 14·60 | 19·30 | 15·75 | 21·89 | 10·80 | ·80 | ·30 | 114·39 |
| Akassa ... | 1·30 | 5·29 | 8·31 | 8·75 | 11·74 | 27·08 | 21·18 | 8·40 | 25·32 | 17·23 | 6·77 | 7·55 | 148·92 |
| Bonny ... | 1·50 | 4·00 | — | 9·40 | 7·06 | 29·24 | 17·80 | 19·65 | 16·35 | 13·25 | 11·52 | 2·28 | 132·05 |
| Sapele ... | nil | ·10 | 3·54 | 10·29 | 6·90 | 18·84 | 16·64 | 21·09 | 16·42 | 11·42 | nil | nil | 105·24 |
| Warri ... | 1·57 | ·29 | 2·47 | 8·25 | 8·00 | 24·74 | 9·15 | 19·17 | 19·49 | 9·65 | 4·50 | ·35 | 107·63 |
| Owerri ... | ·68 | 2·91 | 1·56 | 8·89 | 6·27 | 14·60 | 8·26 | 21·85 | 15·07 | 6·02 | nil | — | 86·01 |
| Opobo ... | ·71 | 4·65 | 2·85 | 5·56 | 4·82 | 10·88 | 18·37 | 23·24 | 19·33 | 14·08 | 5·42 | nil | 109·91 |
| Onitsha ... | ·43 | 1·82 | 2·06 | 5·34 | 5·26 | 5·54 | 12·09 | 17·67 | 8·87 | 10·34 | nil | ·40 | 69·82 |
| Degema ... | ·85 | ·65 | 4·57 | 9·73 | 9·69 | 8·91 | 11·61 | 10·98 | 13·57 | 4·28 | 3·30 | nil | 78·14 |
| Epe ... | ·57 | ·95 | ·54 | 6·46 | 10·39 | 14·50 | 22·41 | 9·98 | 7·48 | 7·95 | ·37 | ·49 | 82·09 |
| Abo ... | ·66 | ·53 | 3·35 | 3·42 | 17·30 | 11·84 | 15·90 | 8·98 | 7·99 | 3·96 | nil | nil | 73·93 |
| Benin City | nil | ·89 | ·71 | 1·51 | 10·24 | 12·44 | 10·94 | 15·75 | 18·08 | 8·96 | 1·50 | nil | 81·02 |
| Olokemeji | nil | nil | 3·87 | 6·19 | 6·49 | 9·56 | 5·83 | 6·48 | 6·41 | 7·02 | ·94 | nil | 52·79 |
| Ondo ... | — | ·12 | 1·45 | 4·35 | 4·37 | 8·44 | 13·67 | 14·14 | 11·03 | 6·28 | nil | — | 63·85 |
| Lagos ... | ·38 | ·08 | ·94 | 4·48 | 8·79 | 16·70 | 21·39 | 2·82 | 4·95 | 7·00 | 1·86 | ·14 | 69·53 |
| Oshogbo ... | ·01 | ·98 | 3·36 | 4·80 | 7·03 | 4·29 | 8·72 | — | 7·47 | 4·29 | ·48 | nil | 41·43 |
| Ibadan ... | ·23 | ·53 | 2·71 | 10·44 | 6·25 | 9·18 | 9·91 | 5·94 | 4·37 | 10·44 | nil | nil | 60·01 |
| Badagri ... | nil | nil | 1·77 | 3·57 | 6·07 | 11·99 | 17·17 | ·80 | 4·63 | 5·96 | 1·10 | nil | 53·06 |
| Abeokuta | nil | 1·28 | 2·99 | 7·71 | 4·62 | 5·21 | 11·03 | 3·45 | 6·35 | — | — | — | 42·64 |
| Otta ... | nil | ·55 | 2·11 | 4·35 | 10·25 | 6·90 | 8·88 | 3·40 | 5·55 | 6·45 | nil | nil | 48·44 |

In Table B are given the monthly records of the rainfall for 22 stations throughout the Colony for the years 1909 and 1910. These have been arranged in order of descending totals for the year 1909, and while it will be noticed that for this particular year the order is not precisely the same as in the table of the mean annual rainfall for the six years, still the grouping is not materially affected. A comparison of the tables for 1909 and 1910 also shows that there are certain discrepancies, and that although there is, in general, a diminution from the south northwards, certain stations, for example, Ondo and Olokemeji, do not fall within this category. The reason for this is not at first very evident, but an examination of the tables will show that in the drier regions where there are large hills or dense forest, the rainfall is always greater ; this explains away the apparent anomaly of Ondo, Olokemeji, and stations in the vicinity of the Kameruns.

Let us now consider for a moment the duration of the dry season in the various regions, and for this purpose we may neglect a rainfall of below 1·5 inches in any one month. In 1909, at no station were there two months without any rain, while, even disregarding 1·5 inches, never did the number of dry months exceed three. The driest months were December and January ; February came next with a low rainfall, and only slightly higher was November. In 1910, however, November, December, January and February might be regarded as comparatively dry months, but it will be seen that in the delta region at Akassa and Brass even in February there was a rainfall of 5·49 inches and 4·57 inches respectively, while in November the rainfall at Brass, Bonny, and Akassa was 12·52, 11·52 and 6·77 inches respectively.

Generally speaking, the dry season lasts from November to February and tends to increase in length from the south northwards. This will be most easily seen by comparing Calabar, Bonny, Brass and Akassa with Olokemeji, Oshogbo, Otta and Ibadan, but even then one must always bear in mind that in different years rain may fall during all four months. Consequently, it is hardly justifiable to speak of a true dry season in Southern Nigeria. In the inland parts there is an approach to a dry season, and this period gradually increases in Northern Nigeria, until in the northern regions of that Protectorate there is a definite division of the year into a wet and a dry season.

The records of blood-sucking insects from both Northern and Southern Nigeria are perhaps too scanty to admit of any definite deductions being drawn, but in another part of this paper, when discussing the genus *Glossina*, I hope to show that the distribution of the various species in these two colonies is closely correlated with the rainfall and relative humidity.

A consideration of the monthly rainfall at Ondo and Olokemeji will show how the apparent discrepancy in the total rainfall for the year is brought about. Although the annual total is greater in this region than one would be led to expect, it will be seen that this is due, not to a rainfall extending over a greater number of months, but to a greater monthly intensity during the rainy season.

A comparison of the monthly records for the various stations in Table B will also show what is meant by two annual maxima. It will be evident that, as a general rule, although it varies in different years and at various stations in the same year, the rainfall increases gradually from January to about the end of

June or early in July, after which it abates somewhat, and the curve falls considerably during July and early August, when the rain again increases in intensity until September or October is reached, again diminishing in amount till January. The maximum in June to July is much greater than that in September to October, while the minimum in August does not fall so low as in December to January. Thus, in the southern belt, rain falls during nearly every month in the year, but there are two well marked maxima and minima in the rainfall curves. This is known as the equatorial type. These maxima tend to fuse in the northern part, especially in the Western Province, to form one annual maximum; the number of months with a small rainfall increases, and there are some without any. This can be seen most readily by plotting out graphs for the various stations.

## TABLE C.

*Analysis of Rainfall for* 1910.

| Station. | — | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brass ... | Max. | ·58 | 1·77 | 2·24 | 1·26 | 2·18 | 3·50 | 7·45 | 2·61 | 5·43 | 3·32 | 3·75 | 2·80 |
| | Days | 2 | 9 | 10 | 13 | 12 | 20 | 14 | 22 | 25 | 20 | 17 | 9 |
| Calabar ... | Max. | — | ·83 | ·58 | ·65 | 1·65 | ·80 | 2·10 | 4·05 | 3·40 | 2·20 | — | ·29 |
| | Days | — | 6 | 4 | 15 | 14 | 18 | 21 | 31 | 21 | 18 | — | 2 |
| Forcados... | Max. | ·05 | 1·60 | 1·10 | 1·80 | 3·10 | 1·60 | 3·10 | 3·10 | 5·10 | 2·30 | ·50 | ·30 |
| | Days | 1 | 4 | 6 | 11 | 20 | 19 | 21 | 20 | 18 | 17 | 2 | 1 |
| Akassa ... | Max. | ·56 | 2·20 | 2·68 | 1·47 | 2·45 | 7·74 | 5·33 | 1·96 | 4·05 | 3·15 | 1·03 | 2·15 |
| | Days | 6 | 11 | 11 | 16 | 13 | 19 | 16 | 20 | 22 | 23 | 15 | 7 |
| Bonny ... | Max. | 1·00 | 1·50 | — | 2·33 | 2·38 | 7·50 | 3·00 | 3·35 | 3·10 | 2·50 | 3·10 | 1·44 |
| | Days | 2 | 5 | — | 15 | 15 | 15 | 11 | 14 | 9 | 9 | 10 | 8 |
| Sapele ... | Max. | — | ·10 | 1·50 | 2·10 | ·88 | 4·20 | 3·72 | 3·50 | 2·70 | 3·66 | nil | nil |
| | Days | — | 1 | 7 | 9 | 13 | 14 | 13 | 16 | 15 | 10 | nil | nil |
| Warri ... | Max. | 1·57 | — | 1·19 | 2·32 | 2·05 | 7·40 | 2·05 | 6·11 | 4·00 | 2·40 | ·96 | ·24 |
| | Days | 1 | — | 4 | 7 | 10 | 14 | 9 | 20 | 15 | 9 | 7 | 3 |
| Owerri ... | Max. | ·41 | 1·95 | 1·52 | 3·05 | 1·08 | 2·33 | 2·05 | 3·10 | 2·11 | 1·45 | nil | — |
| | Days | 2 | 3 | 2 | 11 | 16 | 21 | 14 | 24 | 22 | 12 | nil | — |
| Opobo ... | Max. | ·33 | — | 1·07 | 1·50 | 1·55 | 4·15 | 4·52 | 2·47 | 4·05 | 2·92 | 1·20 | nil |
| | Days | 3 | — | 4 | 10 | 8 | 15 | 12 | 21 | 14 | 16 | 9 | nil |
| Onitsha ... | Max. | ·35 | 1·05 | 1·05 | 2·05 | ·85 | 1·56 | 3·40 | 2·83 | 2·27 | 2·20 | nil | ·40 |
| | Days | 2 | 4 | 3 | 7 | 11 | 9 | 17 | 19 | 14 | 13 | nil | 1 |
| Degema ... | Max. | ·55 | ·31 | 1·90 | 1·70 | 2·10 | 2·12 | 3·56 | 1·48 | 2·62 | 1·95 | 1·76 | nil |
| | Days | 2 | 3 | 5 | 9 | 16 | 11 | 14 | 24 | 11 | 8 | 4 | nil |
| Epe ... | Max. | ·57 | ·60 | ·24 | 1·97 | 1·76 | 2·55 | 8·25 | 1·88 | 1·80 | 1·64 | ·14 | — |
| | Days | 1 | 2 | 3 | 8 | 11 | 11 | 18 | 11 | 12 | 11 | 3 | — |
| Abo ... | Max. | ·41 | ·44 | 1·12 | 1·27 | 4·34 | 3·02 | 8·20 | ·98 | ·83 | ·67 | nil | nil |
| | Days | 2 | 3 | 4 | 10 | 13 | 19 | 22 | 26 | 23 | 13 | nil | nil |
| Benin City | Max. | — | ·86 | ·67 | ·46 | 1·64 | 4·15 | 1·75 | 3·73 | 2·43 | 1·48 | ·80 | nil |
| | Days | — | 2 | 2 | 6 | 12 | 13 | 21 | 23 | 19 | 17 | 3 | nil |
| Olokemeji | Max. | nil | nil | 2·04 | 2·67 | 1·70 | 2·89 | ·31 | 1·42 | 1·52 | 1·43 | ·94 | nil |
| | Days | nil | nil | 6 | 11 | 11 | 17 | 19 | 23 | 21 | 19 | 1 | nil |
| Ondo ... | Max. | — | ·12 | ·80 | ·85 | 1·53 | 1·52 | 1·51 | 7·04 | 2·50 | ·92 | nil | — |
| | Days | — | 1 | 4 | 8 | 4 | 15 | 5 | 18 | 15 | 16 | nil | — |
| Lagos ... | Max. | ·38 | ·07 | ·73 | 1·31 | 1·43 | 5·00 | 4·10 | ·92 | 2·45 | 2·06 | 1·11 | ·11 |
| | Days | 1 | 2 | 2 | 8 | 15 | 22 | 17 | 17 | 13 | 12 | 3 | 2 |
| Oshogbo ... | Max. | ·01 | ·95 | 1·34 | 1·12 | 1·12 | ·91 | 2·31 | — | 1·81 | ·91 | ·47 | nil |
| | Days | 1 | 3 | 4 | 10 | 13 | 18 | 14 | — | 13 | 18 | 2 | nil |
| Ibadan ... | Max. | ·23 | ·36 | 1·25 | 3·20 | 1·91 | 2·42 | 3·45 | 1·60 | 1·13 | 2·05 | nil | - |
| | Days | 1 | 2 | 8 | 11 | 8 | 10 | 15 | 11 | 8 | 11 | nil | |
| Badagri ... | Max. | nil | — | — | 1·30 | 1·24 | — | 3·95 | ·30 | 2·05 | 2·70 | ·70 | nil |
| | Days | nil | — | — | 6 | 11 | — | 9 | 5 | 3 | 5 | 3 | nil |

Table C has been prepared to demonstrate more clearly the nature and extent of the dry and the wet seasons at the various stations in the Colony. The first line for each station gives the maximum rainfall for any one day in each month, while the second shows the number of days on which rain fell at the respective stations in each month. An examination of the data reveals several important facts:—(1) the enormous daily rainfall during the wet season in the Niger delta, *e.g.*, 7·45 inches in one day in July at Brass, 7·74 inches in one day in June at Akassa, 7·40 inches at Warri in June, and 8·25 inches at Epe in July within the same time; whereas in the northern districts, *e.g.*, at Olokemeji, 2·67 inches in April and 2·89 inches in June were the highest daily rainfalls recorded in 1910. (2) It also shows how the rainfall given in Table B was distributed throughout the various months. (3) A comparison of the number of days on which rain fell in the different months will also emphasise the nature of the compound curve of rainfall and the relative positions of its maxima. This would, however, have been more evident had it been possible to give the records in half-monthly frequency.

### Table D.

*Mean Monthly Humidity for* 1910.

| Station. | Jan. | Feb. | Mar. | Apr. | May. | June | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brass ... | 93 | 78 | 78 | 78 | 74 | 77 | 81 | 84 | 75 | 85 | 80 | 80 | 80·2 |
| Calabar ... | 92 | 89 | 82 | 92 | 93 | 92 | 89 | — | 90 | 72 | — | 90 | 88·1 |
| Forcados ... | 86 | 83 | 74 | 85 | 87 | 93 | 88 | — | 95 | 80 | 80 | 80 | 84·6 |
| Akassa ... | 73 | 90 | 76 | 75 | 76 | 73 | 80 | 80 | 80 | 85 | 85 | 80 | 79·4 |
| Bonny ... | 89 | 93 | — | 100 | 91 | 92 | 88 | 87 | 85 | 89 | 90 | 95 | 90·8 |
| Sapele ... | 88 | 86 | 79 | 71 | 90 | 65? | 90 | 91 | 59 | 85 | 90 | 94 | 82·3 |
| Warri ... | 88 | — | 88 | 90 | 64 | 71 | 92 | — | 94 | 85 | 85 | 94 | 85·1 |
| Owerri ... | 87 | 73 | 66 | 76 | 75 | 83 | 82 | 90 | 75 | 80 | 80 | — | 78·8 |
| Opobo ... | 91 | — | 81 | 78 | 33? | 89 | 87 | 78 | 80 | 95 | 95 | 95 | 82·0 |
| Onitsha ... | 84 | 83 | 80 | 90 | 90 | 87 | 89 | — | 89 | 89 | 85 | 89 | 86·8 |
| Degema ... | 87 | 86 | 90 | 87 | 83 | 91 | 87 | 97 | 85 | 85 | 85 | 85 | 87·3 |
| Epe ... | 83 | 91 | 84 | 81 | 81 | 87 | 93 | — | — | 79 | 85 | 85 | 84·9 |
| Abo ... | 83 | 86 | 76 | 85 | 83 | 82 | 81 | 84 | 80 | 76 | 80 | 85 | 81·7 |
| Benin City | 96 | 95 | 99 | 96 | 94 | 95 | 95 | — | 94 | 94 | 94 | 89 | 94·6 |
| Olokemeji | 75 | 81 | 73 | 84 | 83 | 86 | 87 | 82 | 89 | 94 | 85 | 95 | 84·5 |
| Ondo ... | — | 74 | 84 | 59? | — | 84 | — | 71 | 84 | 84 | 78 | — | 77·2 |
| Lagos ... | 63 | 71 | 68 | 73 | 74 | 77 | 80 | 82 | 77 | 77 | 73 | 74 | 74·0 |
| Oshogbo ... | 62 | 83 | 68 | — | — | — | — | — | — | — | — | — | 71·0 |
| Ibadan ... | 75 | 93 | 86 | 80 | 92 | 89 | 91 | 92 | 94 | 79 | 89 | — | 87·2 |
| Badagri ... | 79 | 81 | — | 81 | 74 | — | 78 | — | 75 | 80 | 80 | 72 | 77·7 |
| Abeokuta ... | 85 | 90 | — | — | — | 94 | 99 | — | — | — | 95 | — | 92·6 |
| Otta ... | — | — | — | — | — | 98 | 87 | 89 | 79 | — | 85 | 85 | 87·1 |

Table D gives the mean humidity for each month in 1910 at the same twenty-two stations. A comparison of this table with that given for Northern Nigeria* will show how much greater is the general humidity near the coast than in the upland districts, for the annual means are about on a level with the average annual maxima in Northern Nigeria. It is unnecessary to discuss the details, but a glance will be sufficient to show that in the delta region there is very little difference in humidity throughout the various months of the year, while in the

* Bull. Ent. Res. II, pt. 4, p. 312.

north, where the dry season is of longer duration, although the humidity may reach a very high percentage in the wet season, it does not maintain its intensity during the months when there is little rainfall.

### Table E.

*Monthly Temperatures for* 1909.

| Station. | | Jan. | Feb. | Mar. | Apl. | May. | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Olokemeji ... | Max. ... | 98 | 97 | 95 | 96 | 96 | 90 | 88 | 89 | 89 | 92 | 94 | 95 | 93·2 |
| | Min. ... | 54 | 69 | 68 | 68 | 68 | 63 | 68 | 68 | 67 | 67 | 69 | 58 | 65·6 |
| | Av. Max. | 92 | 87·8 | 88·1 | 90·4 | 90 | 86·5 | 84·2 | 83·7 | 83·9 | 89 | 91·8 | 91·0 | 88·2 |
| | Av. Min. | 69·4 | 73·5 | 73 | 73·1 | 72·6 | 72·3 | 72 | 71·3 | 70·6 | 71·6 | 73·6 | 69·9 | 71·9 |
| Onitsha ... | Max. ... | 94 | 94 | 96 | 97 | 96 | 94 | 88 | 89 | 91 | 91 | 94 | 92 | 93 |
| | Min. ... | 63 | 70 | 69 | 69 | 68 | 68 | 67 | 69 | 69 | 69 | 69 | 69 | 68·2 |
| | Av. Max. | 89·2 | 90·1 | 91·3 | 92 | 90·4 | 87·3 | 83·6 | 83·7 | 85·6 | 86·4 | 89·9 | 86·6 | 88 |
| | Av. Min. | 72 | 74·4 | 74·3 | 73·3 | 73·2 | 72·1 | 71·4 | 71·7 | 72·5 | 74 | 74 | 74 | 73 |
| Ibadan ... | Max. ... | 95 | 96 | 94 | 97 | 93 | 90 | 88 | 87 | 88 | 95 | 96 | 96 | 92·9 |
| | Min. ... | 55 | 61 | 61 | 59 | 61 | 59 | 60 | 60 | 58 | 59 | 61 | 59 | 59·4 |
| | Av. Max. | 90·9 | 92·3 | 91·1 | 90·7 | 89·8 | 85·8 | 82·6 | 82·2 | 84·5 | 88 | 84·8 | 91·5 | 87·8 |
| | Av. Min. | 64·7 | 69 | 65·8 | 64·3 | 64 | 63·3 | 62·5 | 61·4 | 61 | 62·2 | 65·1 | 64·3 | 63·8 |
| Sapele ... | Max. ... | 90 | 95 | 92 | 94 | 93 | 95 | 93 | 90 | 96 | 95 | 92 | 89 | 92·8 |
| | Min. ... | 60 | 70 | 70 | 69 | 70 | 70 | 60 | 60 | 69 | 67 | 71 | 69 | 67 |
| | Av. Max. | 86·5 | 89 | 88·3 | 88·9 | 89 | 85·7 | 83·8 | 83·6 | 84·4 | 87·5 | 88·2 | 86·2 | 86·7 |
| | Av. Min. | 70·6 | 73·3 | 74·6 | 73.4 | 73·1 | 72·3 | 67·7 | 63·3 | 70·5 | 72 | 72·4 | 71·9 | 71·2 |
| Owerri ... | Max. ... | 92 | 93 | 94 | 96 | 95 | 92 | 87 | 87 | 88 | 91 | 92 | 92 | 91·6 |
| | Min. ... | 60 | 65 | 64 | 65 | 65 | 64 | 65 | 65 | 61 | 63 | 65 | 63 | 63·7 |
| | Av. Max. | 89·2 | 91 | 90 | 88 | 92·5 | 88·6 | 84·5 | 84 | 84·7 | 87 | 88·8 | 88·7 | 88·1 |
| | Av. Min. | 66 | 69 | 69·3 | 67·8 | 67·9 | 66·8 | 66·9 | 67·1 | 66·1 | 66·4 | 69·6 | 67·4 | 67·5 |
| Forcados ... | Max. ... | 99 | 89 | 90 | 90 | 92 | 89 | 90 | 89 | 90 | 90 | 90 | 94 | 91 |
| | Min. ... | 59 | 64 | 62 | 60 | 60 | 59 | 59 | 59 | 59 | 65 | 60 | 64 | 60·8 |
| | Av. Max. | 89 | 84·1 | 86·8 | 87·1 | 86·8 | 84·7 | 85·1 | 85 | 86·8 | 87 | 86·9 | 88·4 | 86·4 |
| | Av. Min. | 66·6 | 68 | 70·3 | 66·2 | 65·2 | 64·7 | 65·2 | 66 | 65·5 | 66·7 | 65·9 | 66 | 66·3 |
| Calabar ... | Max. ... | 95 | 92 | 92 | 93 | 93 | 91 | 89 | 88 | 80 | 90 | 90 | 91 | 91 |
| | Min. ... | 64 | 70 | 70 | 70 | 70 | 69 | 70 | 71 | 70 | 71 | 71 | 70 | 69·6 |
| | Av. Max. | 89 | 88 | 89·6 | 89·8 | 90 | 87·7 | 86·4 | 86 | 86·1 | 88·9 | 89·1 | 89·4 | 88·3 |
| | Av. Min. | 73 | 72 | 71·5 | 70·5 | 70·6 | 70 | 70·4 | 71 | 70·3 | 71 | 71·2 | 70·7 | 71 |
| Oshogbo ... | Max. ... | 94 | 95 | 96 | 95 | 92 | 92 | 84 | 83 | 91 | 87 | 88 | 89 | 90·5 |
| | Min. ... | 58 | 60 | 64 | 68 | 67 | 65 | 64 | 64 | 68 | 65 | 65 | 64 | 64·3 |
| | Av. Max. | 91·6 | 91·4 | 92·4 | 91·2 | 88 | 87·9 | 79 | 79·1 | 88 | 84·3 | 86·2 | 86·4 | 87·1 |
| | Av. Min. | 62·4 | 64 | 68·5 | 70·9 | 69·7 | 67·7 | 66·2 | 66·2 | 69·8 | 69 | 71·5 | 70·3 | 68 |
| Brass ... | Max. ... | 92 | 92 | 92 | 92 | 92 | 90 | 88 | 88 | 88 | 90 | 91 | 90 | 90·4 |
| | Min. ... | 52 | 59 | 60 | 63 | 71 | 70 | 71 | 71 | 68 | 68 | 70 | 67 | 65·7 |
| | Av. Max. | 86 | 89·7 | 89·5 | 85·5 | 88·7 | 84·8 | 82·6 | 85·5 | 84·9 | 86·3 | 87·3 | 87·6 | 86·5 |
| | Av. Min. | 62·6 | 64 | 64·2 | 69·8 | 74·7 | 73·2 | 73·4 | 74 | 73·7 | 72·8 | 74 | 73·1 | 70·8 |
| Bonny ... | Max. ... | 89 | 90 | 92 | 99 | 96 | 90 | 78 | 85 | 89 | 91 | 89 | 90 | 89·8 |
| | Min. ... | 66 | 68 | 66 | 60 | 71 | 66 | 68 | 70 | 67 | 68 | 68 | 71 | 67·4 |
| | Av. Max. | 86·4 | 86·8 | 89·2 | 89·2 | 88·2 | 82 | 80·2 | 83·9 | 82·0 | 84·8 | 86 | 88·5 | 85·6 |
| | Av. Min. | 72·8 | 73·8 | 72·2 | 73·2 | 4 | 72·8 | 71·3 | 72·1 | 71·1 | 70·7 | 71·1 | 72·4 | 72·3 |
| Lagos ... | Max. ... | 91 | 90 | 93 | 91 | 90 | 89 | 85·2 | 88 | 87 | 89 | 91 | 90 | 89·5 |
| | Min. ... | 68 | 71 | 73 | 72 | 73 | 70 | 71 | 71 | 70 | 71 | 72 | 71 | 71 |
| | Av. Max. | 86·8 | 87·4 | 89·9 | 87·8 | 87·9 | 87·4 | 82·7 | 83·7 | 84·5 | 86·3 | 87·9 | 87·7 | 86·5 |
| | Av. Min. | 73·8 | 75·7 | 77·2 | 76·4 | 76 | 74 | 74·1 | 73·8 | 73·1 | 74·1 | 75·6 | 75 | 74·9 |
| Degema ... | Max. ... | 89 | 89 | 90 | 95 | 97 | 85 | 89 | 86 | 85 | 88 | 89 | 89 | 89·2 |
| | Min. ... | 70 | 72 | 69 | 71 | 69 | 65 | 61 | 69 | 64 | 62 | 68 | 72 | 67·6 |
| | Av. Max. | 86·1 | 87 | 87·1 | 87·2 | 85·8 | 80·8 | 79 | 81 | 80 | 81·8 | 83 | 84·8 | 83·6 |
| | Av. Min. | 71·5 | 76·2 | 75·5 | 75·4 | 73·6 | 71·8 | 70·1 | 73 | 72 | 71·8 | 74·2 | 76 | 73·8 |
| Badagri ... | Max. ... | 87 | 89 | 88 | 89 | 90 | 86 | 84 | 84 | 84 | 87 | 88 | 88 | 87 |
| | Min. ... | 61 | 66 | 67 | 63 | 70 | 71 | 67 | 69 | 70 | 66 | 66 | 67 | 67 |
| | Av. Max. | 85·1 | 85·4 | 86·3 | 85·9 | 86·3 | 81·8 | 81·3 | 81·1 | 81·4 | 84 | 86·7 | 86 | 84·3 |
| | Av. Min. | 71·5 | 73·3 | 74·6 | 73·8 | 76·6 | 77·5 | 73·6 | 71·8 | 71·7 | 71·2 | 73·1 | 71 | 73·3 |

In Table E I have collected the records of monthly temperatures for thirteen stations in the Colony, giving (1) the maximum for one day during each month, (2) the minimum for one day during the month, (3) the average maximum for the month, and (4) the average minimum for the month. The stations have been arranged in descending annual maxima. It is unnecessary to enter into any detailed discussion of the various data here presented, but I should like to draw attention to some of the major features :—

(1) The means of the average monthly maxima all lie within a very circumscribed compass ; at one extreme stands Calabar with a mean of 88·3° F., and at the other Degema with a mean of 83·6° F.

(2) The means of the average monthly minima show a similarly low range ; for example, Lagos with 74·9° and Ibadan with 63·8° are the most diverse.

(3) The difference between the maxima for the various months is comparatively slight. Thus, the greatest divergence was 21° at Bonny (99° in April and 78°* in July), while at Oshogbo the difference was only 13°, and at Brass it was least of all—namely, 4°. The range is least in the delta region, and greatest in the north.

(4) The same is true with regard to the range in the minima.

(5) The difference between the maximum and minimum in any one month is greatest in the dry season, and, generally speaking, more in the north than in the south.

The extremes of shade temperature recorded for S. Nigeria are 46° and 110° ; the highest average of maximum shade temperature is 93·2° at Olokemeji, and the lowest average of minimum 59·40° at Ibadan, both in the Western Province.

The mean height of the barometer at sea-level is about 30 inches, with a total range of 0·10 inches between the highest and lowest readings during the day-time.

It must not be considered that these few observations by any means exhaust the deductions to be drawn from these tables, but they constitute the most important from the point of view of the distribution of the insect fauna, and when these are borne in mind, many points, otherwise obscure, will be found to be correlated with the general climatic conditions.

The whole may be recapitulated thus :—

(1) Stations in the same latitude have similar rainfalls.

(2) The rainfall is greatest successively at Calabar, in the Niger delta, and in the lagoon region along the coast, and diminishes from the south northwards, except along the river basins and in the hilly regions.

(3) Where the rainfall in the north, *e.g.*, at Ondo, is greater than in the surrounding country, it is due to a greater intensity during a few months, and not to an increase in the number of rainy months.

(4) The rainfall curve is of the equatorial type—that is, there are two annual maxima and minima, the maxima tending to fuse into one in the northern parts of the Western Province.

(5) The dry and wet seasons are not very definitely separated, but the rainfall is almost negligible from November to February, and the duration of this dry season increases from south to north.

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* It is not improbable that this record is much too low.

(6) The humidity is greatest in the delta of the Niger and is much greater in Southern than in Northern Nigeria, the monthly range increasing from south to north.

(7) The means of the average monthly maximum temperatures, and also of the minima all lie within a very circumscribed compass.

(8) The range in the maxima for the various months increases from south to north, as also does the difference between the maximum and minimum in any month, this difference being greatest in the dry season.

## III. Narrative.

### (*a*) *The Western Province.*

This province, which includes the old Colony of Lagos, is situated in the Bight of Benin, and extends from French Dahomey on the west to the Central Province of Southern Nigeria and the Kabba Province of Northern Nigeria on the east, while on the north it is bounded by the provinces of Ilorin and Borgu in Northern Nigeria. It has an area of over 28,000 square miles and a population of over two and a half millions.

Topographically it is distinct from the rest of the Protectorate and also from Northern Nigeria, but is more intimately connected with French Dahomey. With the exception of the lagoons in the south, which connect with the delta of the Niger, it has its own distinctive river system. It is irrigated by several small rivers with innumerable tributaries, practically all of which have their origin within the Province. These pour their waters into the series of lagoons which unite and connect with the sea at Lagos.

The hills of Shaki in the north and those of Ilesha in the north-east form the water-shed between this system and the tributaries of the Niger which flow northwards in this region, while the Idanre hills in the Ondo District constitute a dividing line between the rivers of the Western and Central Provinces.

The largest and most important river in the Province under discussion is the Ogun, which rises practically at the boundary of Northern and Southern Nigeria in the extreme north-west, runs almost due south through the districts of Shaki, Oyo, Ibadan, and Abeokuta, and empties itself into the Lagos lagoon between Ebutemetta and Ikorodu. On this river the most important towns are Olokemeji, Aro, and Abeokuta, all of which are on the Lagos Railway, which follows the valley of the river from Ebutemetta to a point some distance north of Eruwa Road.

The chief tributaries of the Ogun River are the Opeki, the Oyun, the Owiwi, and the Awon, which all rise in the highlands of Shaki, and, running in a south-easterly direction, join the Ogun on its right bank.

West of the Ogun River, the only stream of any importance is the Yewa River, which rises in French Dahomey and enters Nigeria south of Meko. Running almost due south through the district of Badagri, close to the French border, it enters the Badagri lagoon near the town of that name.

East of the Ogun River are a large number of small streams which rise in the north of the Ibadan and Ilesha districts, and flow almost due south to enter the

system of lagoons which lie parallel with the coast-line. The chief of these are the Owuri, which flows into the Lagos lagoon, the Omi into the Ikorodu lagoon, the Oshun, the Shasha, and the Oni, which pour their waters into the Lekki lagoon, and the Oluwa River, which empties itself into the Mahin lagoon. It must be remembered, however, that all these lagoons are united and open to the sea only at one point, namely, near Lagos.

It will thus be seen from the general direction of the flow of these rivers, namely, almost due south, that there is a gradual diminution in the altitude from the north southwards, interrupted by no intrusive ranges of hills of any importance. For this reason, in considering the physical configuration of the Province, it is convenient to divide the country into four zones more or less parallel with the coast.

The first, or outer, zone consists of long peninsulas, islands and sandbanks which separate the ocean from the series of lagoons already mentioned. These lagoons, though all connected, vary considerably in depth and expanse; in some places they widen out into extensive lakes, at others they contract into narrow channels enclosing numerous flat marshy islands or sandbanks. In most parts these waterways are navigable for small launches, and by this means there is a regular marine service between Lagos and Badagri on the west, and on the east between Ikorodu, Epe and Siluko on the boundary between the Western and Central Provinces, some fifty miles from the sea.

Beyond the lagoon area, for some ten miles inland, there is a flat tract of country, in some places sandy and much cultivated, in others consisting of numerous extensive swamps. In the latter area the inhabitants are chiefly fishermen and salt-collectors. During and after the rains many of these swamps become small lakes and connect with the main lagoons by small channels which are often navigable for canoes.

Beyond this second zone the forest country commences, and the land gradually rises until the watershed of the Niger is reached, which is formed by an oblique range of hills between the 8th and 9th parallels, consisting of the Idanre hills, and the highlands of Ilesha, Oshogbo and Shaki. In some parts (for example, the Forest of Ondo), the vegetation is very thick, and there are abundant large high trees, whose foliage serves to produce a very dense shade. In such forests the stillness, broken only by the chirruping of the cicadas, is oppressive; the temperature is several degrees lower than in the open, but the moist clammy air is almost suffocating. In other parts, however, there are numerous large expanses of undulating park-like country, where a certain amount of cultivation is done, but on the whole the population is scanty.

Beyond this forest region, which north of Lagos is about 40 miles wide, the country opens out, and extensive views can be had from the tops of the small hills, *e.g.*, at Abeokuta and Meko, and beyond this the country is, for the most part, open and fertile. The population is very dense in this area, and there are a few towns of very large size, *e.g.*, Ibadan with 200,000 and Oshogbo with 40,000 inhabitants. Towards the boundary of Northern Nigeria there are bare granitic, gneiss and schistose hills; the country is much drier, and the trees are thinly scattered, low and stunted.

Politically, the Western Province is divided into a number of districts, and for the present purpose it might be well to discuss each of these in turn, always having regard to the various hydrographic systems. From west to east are the Rivers Yewa and Ogun, which drain the districts of Badagri, Meko, Abeokuta, part of Ibadan, Oyo and Shaki; and these, along with Lagos, form an almost complete unit. In the east are the various small rivers already mentioned, draining the districts of Ikorodu, Epe, Ijebbu Ode, Ondo, Ilesha, the remainder of Ibadan and Oshogbo; and these again form a more or less distinct topographical unit. The Lagos Railway in its lower portion passes through the first-named area, while beyond Ibadan it enters the second, and continues within it until it reaches Northern Nigeria at Offa.

### (1) Badagri.

This is one of the most westerly districts in the Province, and is bounded on the west by French Dahomey. The only river of any importance in the district is the Yewa, which is navigable for a short distance for small launches, and to Egoa for moderate-sized canoes. A large amount of produce is brought down this river to the town of Badagri, where a large market is held, and there is considerable intercourse with the natives in French Dahomey. The coastal region is low, flat and swampy, and lies on the Badagri lagoon, which is separated from the ocean by a long narrow peninsula. The town of Badagri is reached by steam-launch along the lagoon from Lagos. Inland from the coast area there is a broad forest belt which extends for a distance of 40–50 miles. Beyond this region the country becomes more open and park-like in character, and there is a succession of small hills and valleys, which extend into the Meko district in the north. The whole trend of the country is towards a slight increase in elevation northwards.

In the sub-district of Idi-Oroko, the chief town of which is Okeodan, the country is low and flat, and during the dry season water is very scarce in this part. Guinea-worm is very prevalent all over the district, but more especially in Idi-Oroko.

The chief industries of the natives are agriculture and fishing; sheep and goats are plentiful, but very few cattle and no horses are kept.

Elephant and bush-cow are said to occur on the Yewa River, but with the exception of a few small antelope, and these not in any abundance, there is little game in the district. The natives, especially in the north, are great hunters, and as there are a few guns in every village, the absence of game of all sorts is not surprising.

During my visit to this district at the height of the dry season, in February, 1910, the number of blood-sucking flies was at its minimum. At Badagri the only species seen were *Mansonioides uniformis* and *Tabanus par*, while the former species was also obtained at Ere, and *Myzomyia costalis* at Agilete. From the sheep and dogs at several places numerous ticks were obtained :—*Amblyomma variegatum* on dogs at Ere and Agilete, *Haemaphysalis leachi* and *Rhipicephalus sanguineus* from sheep at Ibesha. At the latter place also *Ctenocephalus canis* was found on dogs, and several *Dermatophilus penetrans* were taken from the

carriers' feet. I examined a long stretch of the river at Egoa, but saw no biting flies of any sort. At this town the dogs were simply swarming with *Ctenocephalus canis*.

Capt. L. E. H. Humfrey, who has made extensive collections of insects from Southern Nigeria, was stationed at Badagri for a short time, and from the "Yewa River" he sent the following species of blood-sucking flies :—*Glossina palpalis*, *Glossina caliginea*, *Tabanus fasciatus*, *T. secedens*, *T. socialis*, *T. taeniola*, *T. thoracinus*, *Chrysops dimidiata** and *Mansonioides uniformis*.

### (2) Meko.

The southern part of this district is for the most part undulating, has a laterite soil, and is covered with open forest of a deciduous type, having an undergrowth of tall grasses and bush, with occasional belts of denser forest, the latter generally associated with the small streams. There are a number of small rivers running south, the chief of which are the Yewa and the Idi, which unite a little to the south of Egoa.

The town of Meko stands on the eastern edge of a large plateau 645 feet above sea level, with an estimated area of five square miles. To the west the descent is very precipitous to the small village of Idofa, nestling in the valley of the Oyo River, a tributary of the Yewa. The main road to Meko is from Aro a station in Egbaland on the Lagos Railway, 60 miles from the terminus at Iddo. Only 13½ miles of this road are in the Meko district.

No blood-sucking flies were seen at Meko during my visit, nor have any been recorded from the plateau itself. A number of species, however, occur at various places on the Aro-Meko road, but these will be referred to later. On the dogs, however, the following parasites were found :—*Haemaphysalis leachi*, *Rhipicephalus sanguineus* and *Ctenocephalus canis*, while on the fowls were numerous *Echidnophaga gallinacea*.

North of the town of Meko there is a small belt of oil-palms. "Further north, palms all but disappear, and the scenery becomes extremely monotonous—everywhere tall grass and trees of such a kind that the general aspect is like that of a thickly planted English orchard with its grass ready for haysel. Cropping up here and there are huge slabs of bare grey gneissic granite, and also hills of the same, partly clothed with trees and herbage ; these are seen best near Okuoshiju's farm and at Owuye (French, and 12 miles north of Meko). Numerous small streams run in all directions except north ; the largest is the Okpara, about 250 feet wide, between Jabata and Wasimi."

### (3) Shaki.

This district is very imperfectly known, but the general configuration of the country is said to be similar to that described above for the northern part of the Meko district. The River Ogun rises in this district near the Northern Nigeria frontier.

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* It is very doubtful whether *C. silacea*, Aust., is really distinct from this species, and it is highly probable that when a larger number of specimens are obtained it will prove to be no more than a mere colour variety.

### (4) Oyo.

The district of Oyo is very similar to Meko. The general type of country is undulating grass-land, sparsely timbered with gnarled and stunted trees. In the north and west there are high rocky hills, generally rising precipitously to a height of 200–300 feet, while scattered about are small patches of forest.

Game is fairly abundant in this northern region, in fact it is probably the best preserve in Southern Nigeria. The smaller antelope are found throughout the whole of these districts; elephant are fairly plentiful, while there are also a few lion, and leopard. Roan antelope, hartebeeste, waterbuck, kob and yellow-backed duiker are also to be found, while monkeys of various sorts are everywhere abundant. Nothing is known of the insect fauna of the country north of the Aro-Meko Road and west of the railway.

Again starting from the south we have now to consider Egbaland and Ibadan, two provinces within the basin of the Ogun River.

### (5) Egbaland.

The southern portion of this independent kingdom ruled over by the Alake, whose residence is at Abeokuta, consists largely of forest, with immense tracts of open country, well watered and extensively cultivated. To the east are a few ranges of hills which separate the Ogun river system from that of the Ogbara, etc., a region abounding in thick forests. The north-eastern portion is open country, low, well watered and largely cultivated.

The Lagos Railway runs through a considerable part of this territory within a short distance of the capital, Abeokuta, which has a population of over 60,000. The town of Aro and the greater part of the Aro-Meko road is also in Egbaland, and here the following blood-sucking flies have been found :—

(In addition to those collected by the writer the records made by Drs. G. Gray and J. Copland, both of whom were stationed at different times at Aro, and who made large collections while travelling to and from Meko, have been added.)

At Aro :—*Mansonioides uniformis*, *Myzomyia costalis* and *Tabanus taeniola*. Both species of mosquito were very troublesome during the writer's sojourn in February.

At Olarunda market (one of the usual camping places on the Aro-Meko Road) :—*Hippocentrum versicolor*.

At Edi-Emi (the other camping ground on this road) :—*Glossina longipalpis*, *Tabanus subangustus*, *Hippocentrum versicolor* and *Subpangonia gravoti*.

At several other places on this road *Glossina longipalpis* has been found, while *Haematopota tenuicrus* has also been recorded.

From the dogs at Aro *Rhipicephalus sanguineus*, *Boophilus decoloratus* and *Ctenocephalus canis* have been taken, while on the sheep at Abeokuta, in addition to *Boophilus decoloratus*, I also found a new species of blood-sucking lice (Anoplura) recently described by Kellogg and Paine* under the name of *Linognathus africanus*.

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* Bull. Ent. Res. II, pt. 2, p. 146.

### (6) Ibadan.

This district lies to the north of Egbaland and consequently partakes of the hilly character of that region. "The whole country lies on eruptive rocks all belonging to the granitic-gneissic family, with approaches here and there to porphyry. North of Ibadan there is little real forest. The country may be described as a rolling plateau with low hills and hardly any virgin land. The average rainfall is 40–50 inches. The cattle thrive although they have ticks and suffer from tsetse-fly, especially in the neighbourhood of rivers."

The only blood-sucking flies recorded from Ibadan are:—*Myzomyia costalis*, *Culiciomyia nebulosa*, *Tabanus taeniola*, *Haematopota decora* and *Hippobosca maculata*. Dr. Ashton informed me that "sandflies," probably *Culicoides grahami*, were very abundant, especially during the wet season and were most troublesome from 6 to 11 A.M. and from 3 P.M. to sunset. None were seen by me during my visit, which occurred towards the end of February.

### (7) Ikorodu.

This is a very small district lying on the Lagos lagoon. The whole area is very low and there is no open country; clearings for farms have been made in the forest in several places. Numerous rivers, streams and back-waters from the lagoon intersect the country in all directions, and these afford an ample water-supply. Many of these water-ways are navigable for canoes. Nothing is known of the insect fauna of this district.

### (8) Epe.

The district of Epe extends along the sea-coast practically from Lagos to the boundary of the Central Province, and includes the two sub-districts of Mahin and Itebu. At no point is it more than twenty-five miles from the coast. Both of the sub-districts, Mahin and Itebu, are low-lying and swampy, the greater part of this area being covered with large trees and thick undergrowth. North of the town of Epe the country is undulating. It was once covered by a huge forest, which has now been cut down and replaced by farms. South of this region to the sea the whole country is low-lying and sandy, and includes numerous lagoons, the largest of which is known as the Lekki Lagoon. Numerous rivers, which rise in the districts to the north, such as Ibadan and Ondo, have their lower reaches in the Epe district, and pour their waters into the various lagoons. The largest of these are the Oshun, the Shasha and the Oni. In addition to these there are numerous creeks, such as the Unu, the Owa and the Mahin. Consequently, waterways are extremely numerous throughout the district and afford communication between Lagos, Epe, and onwards to the Niger.

The chief industry of the district is fishing, but there is also a certain amount of agriculture. Recently, bitumen has been discovered there, and this substance is being exploited by the Southern Nigerian Bitumen Company.

Elephant were formerly abundant, but are now practically extinct. A few antelope still exist, and hippopotami and manatee occur in the rivers and creeks. Our knowledge of the insect fauna of this district is due entirely to the work of

Dr. W. A. Lamborn, who has collected extensively on the Oni River. The following blood-sucking flies have been received from him: *Glossina caliginea*, *G. palpalis*, *G. nigrofusca*, *Tabanus fasciatus*, *T. secedens*, *T. socialis*, *T. thoracinus*, *Chrysops longicornis* and *C. silacea*. With regard to the last-named species he says: "This is the commonest biting fly found in the houses at Oni Station on Lekki Lagoon." Of the three species of *Glossina* which occur in this region *G. caliginea* appears to be by far the most abundant.

### (9) Ijebu-Ode.

This district lies to the north of the western portion of the Epe district. The country is undulating and for the most part covered with thick forest; there are no hills of any importance, and the whole region is well watered by small streams and several large rivers. These latter are the higher reaches of those mentioned in the Epe district.

Bush-cow and some of the larger antelope are found on the Oni river and the surrounding country, but on the whole the district is too thickly forested for game to be abundant. Crocodiles are scarce. Nothing is known of the insect fauna of this district.

### (10) Ondo.

The district of Ondo is much larger than any of those just mentioned; it lies to the north of the eastern half of the Epe district, and extends northwards to Ilesha. The country is hilly and undulating, and there are several large dense forests. To the north are the Idanre Hills, a range of granitic and gneissic rocks, the surrounding country being precipitous on all sides. These hills form the watershed between the river system of the eastern half of this Province and the system of the western half of the Central Province. The whole country is well watered, and there are several large rivers, the most important of which are the Oni, the Owena and the Onishere. The principal creek runs from Agbabu to a point where the Arogbo Creek flows westwards to Mahin and eastwards to Arogbo, and is navigable for steam launches.

Elephant and bush-cow are found in the Onishere and Idanre forests; small antelope and leopard in the Ondo and Akure forests; while crocodiles abound in the lagoons. Sheep, goats, pigs, and a small breed of cattle to which I shall refer later, are to be found in most of the villages.

The part of this district traversed by the writer was from Igbara-Oke through Akure to Owo. The only blood-sucking insect obtained was *Ctenocephalus canis* from goats at Akure. The forests of this province are probably the largest in the Colony, and would well repay examination from an entomological point of view.

### (11) Oshogbo.

North of the districts just discussed lie Oshogbo and Ilesha, which extend to the Northern Nigerian frontier. Politically, Oshogbo is a sub-district of Ibadan, but for the present purpose it merits separate consideration, chiefly from the fact that the insect fauna of this area is, after Yaba, the best known in Southern Nigeria. Dr. T. F. G. Mayer, who was stationed here for some

time, made extensive collections and also bred numerous species of mosquitos from larvae. He has himself published a short report on his observations on the district in a previous number of this Bulletin,* so that it is unnecessary for me to enter into much detail here. I have, however, considered it advisable to include his list of blood-sucking insects for the sake of completeness, along with some other species collected by me during my tour in the district.

The country is for the most part covered with thick bush, and there is also a large number of oil palms. It is well watered by several large rivers, the most important of which are the Oshun, the Otin and the Shasha; the first and last-mentioned of these we have now traced from their mouths to their source, from Epe through Ijebbu-Ode.

The country is undulating and there are no extensive swamps; to the north-east are hills, which separate the Western Province from the Niger system; to the north-west open grass country extends through the district of Oyo to the Shaki highlands; to the south-east thick forest is found, merging into the forest region of the Ondo district.

Game is scarce, but a few antelope and some leopard are still to be found. Of the domestic animals the most common are sheep; goats are also abundant, and in several places one finds a number of cattle, both the hump-backed or "Zebu" variety from Northern Nigeria, and the small native breed. Horses are often introduced from Northern Nigeria but seldom thrive.

The following blood-sucking insects have been found in the district, but I would draw attention to the paper, already cited, by Dr. Mayer on their distribution, numbers and seasonal prevalence.

DIPTERA.—*Glossina palpalis*, *G. longipalpis*, *Stomoxys brunnipes*, *Stomoxys nigra*, *Tabanus quadrisignatus*, *T. subangustus*, *T. pluto*, *Chrysops longicornis*, *C. silacea*, *Hippocentrum versicolor*, *Haematopota decora*, *H. tenuicrus*, *Culex decens*, *C. duttoni*, *C. pruina*, *C. tigripes* var. *fuscus*, *C. zombaensis*, *Myzomyia costalis*, *M. funesta*, *M. umbrosa*, *M. marshalli*, *Myzorhynchus mauritianus*, *M. paludis*, *Mansonioides uniformis*, *Culiciomyia nebulosa*, *Ochlerotatus nigeriensis*, *Stegomyia africana*, *S. fasciata* *S. sugens*, *Eretmopodites quinquevittatus* and *Uranotaenia mayeri*.

SIPHONAPTERA.—*Ctenocephalus canis* from dogs.

MALLOPHAGA.†—*Menopon nigrum* (a new species), *Nirmus varius*, and *Colpocephalum semicinctum*; these were all obtained by the writer from a white-necked raven (*Corvultur albicollis*), and *Colpocephalum flavescens* which was found on a vulture.

IXODOIDEA.—*Boophilus decoloratus* from cows, *Rhipicephalus simpsoni*, Nutt. and Warb., sp. n., on bush-rat and *Rhipicephalus neavei*.

It is interesting to note that from a bush-rat killed by me at Oshogbo, in addition to the new species of tick mentioned above, two new worms were also

* Bull. Ent. Res. II, pt. 3, pp. 273–276 (1911).
† Kellog and Paine, Bull. Ent. Res. II, 2, pp. 147–151 (1911)

obtained. These have been described by Dr. Leiper. Both belonged to new genera, one in the family ANCHYLOSTOMIDAE, *Acheilostoma simpsoni*, the other in the family STRONGYLIDAE, *Trachypharynx nigeriae*.

## (12) Ilesha.

The district of Ilesha may be described as an undulating plain situated in the forest belt ; it is well watered by numerous streams and is surrounded on all sides except the north by ranges of steep hills. The rainfall is about 50 inches annually. Game is scarce, but a few antelope, some leopards and several species of monkeys are to be found.

The region known as Ekiti is separated from Ilesha by a range of precipitous hills, the Efon Range, of about 600 feet above the level of the surrounding country. The area to the south is covered with forest, with occasional stretches of low scrub. To the north, for the most part, the country is open, with small belts of forest along the water-ways. Three large rivers, the Oshun, the Ogbesse and the Owena rise in this district. Antelopes of all descriptions, bush-cow, leopard and pig are abundant. Our knowledge of the blood-sucking insects of the district is principally due to Capt. L. E. H. Humfrey, but collections have also been made by Dr. T. F. G. Mayer and Capt. A. H. Blair. The following are the chief species found among the DIPTERA :—*Glossina fusca*, *G. palpalis*, *Tabanus kingsleyi*, *T. ruficrus*, *T. pluto*, *T. besti*, *Chrysops silacea*, *Rhinomyza stimulans*, *Culiciomyia nebulosa*, *Stegomyia fasciata*, *Eretmopodites inornatus*, *E. quinquevittatus*, and *Mucidus mucidus*.

SIPHONAPTERA :—*Dermatophilus penetrans* and *Ctenocephalus canis*.

MALLOPHAGA :—*Trichochetes climax*, on goats.

IXODOIDEA :—*Rhipicephalus sanguineus* and *Haemaphysalis leachi*.

There remain to be considered only a few localities from which blood-sucking insects have been recorded, and which are not included in the foregoing sections. These are, Lagos, the capital of the Colony ; Yaba, the headquarters of the Medical Research Institute ; and a few isolated localities on the Lagos Government Railway.

## (13) Lagos and Yaba.

From the town of Lagos itself the only blood-sucking flies so far recorded have been mosquitos. Recently Dr. W. M Graham undertook a mosquito survey of this town, and an account of his results has already been published in this Bulletin. It is, therefore, only necessary for me to give a list of the species found. They are as follows :—*Stegomyia fasciata*, *Culiciomyia nebulosa*, *Culex duttoni*, *Culex tigripes* var. *fuscus*, *Culex decens*, *Myzorhynchus obscurus* and *Myzomyia costalis*. I may also mention that while resident at Yaba I obtained numerous fleas from rats sent to Dr. Connal for examination. These were all *Xenopsylla brasiliensis* with the exception of one male *Xenopsylla cheopis*, the transmitter of plague. I believe this is the only record of this flea from Southern Nigeria, though it is very common on the Gold Coast.

The insect fauna of Yaba, about five miles from Lagos and close to the railway, is better known than that of any other part of the Colony, owing to the fact that the Medical Research Institute is erected there. Not long ago Dr. W. M. Graham, assisted by Dr. A. Connal, made exhaustive collections of mosquito larvae, an account of which was published in this Bulletin* by Mr. W. Wesché. Since that time numerous other species, both imagines and larvae, have been received and the complete list is as follows :—*Toxorhynchites brevipalpis*, *Culex consimilis*, *C. pruina*, *C. guiarti*, *C. grahami*, *C. quasigelidus*, *C. duttoni*, *C. tigripes* var. *fuscus*, *C. decens*, *C. invidiosus*, *C. thalassius*, *C. rima*, *Culiciomyia nebulosa*, *Ochlerotatus caliginosus*, *O. longipalpis*, *O. irritans*, *O. domesticus*, *O. punctothoracis*, *O. nigricephalus*, *O. marshalli*, *Stegomyia africana*, *S. apicoargentea*, *S. fusciata*, *S. luteocephala*, *Aëdomyia catasticta*, *Banksinella luteolateralis*, *Taeniorhynchus aurites*, *T. annetti*, *T. violaceus*, *Myzorhynchus umbrosus*, *M. mauritianus*, *Myzomyia costalis*, *Nyssorhynchus pharoensis*, *Mansonioides uniformis*, *Eretmopodites inornatus*, *Mimomyia mimomyiaformis*, *Uranotaenia balfouri*, *U. coeruleocephala*, *U. annulata*, *Ingramia nigra* and *I. uniformis*.

Collections from this locality have also been received from Drs. A. Connal and W. H. Sieger, and from these and the species collected by the writer the following list of blood-sucking insects, other than mosquitos, has been prepared :—

DIPTERA :—*Tabanus billingtoni*, *T. ditaeniatus*, *T. fasciatus*, *T. ruficrus*, *T. laverani*, *T. par*, *T. pluto*, *T. secedens*, *T. subangustus*, *T. taeniola*, *T. thoracinus*, *Chrysops longicornis* and *Hippocentrum versicolor* ; *Glossina fusca* (a single specimen caught by the writer on April 20th, 1910), *Stomoxys calcitrans*, *S. nigra*, and *S. omega* ; *Hippobosca maculata* on cattle ; *Nycteribia sp.* on bats.

SIPHONAPTERA :—*Ctenocephalus canis* from dogs.

IXODOIDEA :—*Amblyomma variegatum* and *Rhipicephalus sanguineus* on dogs.

### (14) Lagos Railway.

The following records from construction camps and stations on the Railway are also worthy of note. At Agege, the source of the new water-supply for the town of Lagos, twelve miles from Iddo, the railway terminus, *Glossina fusca*, *Stomoxys nigra*, *Tabanus taeniola* and *T. pluto* have been caught, while between this point and Aro, sixty miles from Lagos, *Hippocentrum versicolor* was obtained in a railway-carriage at Owowo, and also at a camp $2\frac{1}{2}$ miles from Aro. From Opelifa Dr. G. M. Gray records *Tabanus fasciatus*, *T. taeniola* and *Hippobosca maculata*, as well as the following ticks from horses :—*Amblyomma variegatum*, *Boophilus decoloratus* and *Rhipicephalus sanguineus*. At Opeji, *Dermatophilus penetrans* was found, while from the eighty-five mile camp *Stomoxys nigra* has been recorded. At Olokemeji, the headquarters of the Forestry Department, about midway between Aro and Ibadan, the only blood-sucking insects recorded are *Tabanus taeniola* and *T. socialis*. During my visit there, however, I saw several tsetse, and, though I was unable to obtain any, am of opinion that they were *Glossina longipalpis*.

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* Bull. Ent. Res. I, pt. i, pp. 7–50 (1910).

### (*b*) *The Central Province.*

Owing to the irregular shape of the colony, this Province is situated to the south-east of the Western Province. It extends inland from the Bight of Benin to the Provinces of Kabba and Bassa in Northern Nigeria, and is bounded on the east by the Eastern Province of Southern Nigeria. Its area is roughly about 21,000 square miles and it is therefore slightly smaller than the Western Province ; the total population is approximately 2,000,000.

The physical configuration is far from uniform, and four distinct types may be observed. In the north, but more especially in the north-west, the geological formation is igneous ; the country is slightly elevated, consisting of a series of plateaux, rounded hills and ridges, and thus forms a continuation of the type to be found in the north-west portion of the Western Province and the southern parts of Northern Nigeria.

The second type of formation occupies by far the largest area in the Province, and consists of a sandy stratum of considerable depth, apparently formed from the débris of the igneous rocks. Boulders and stones are absent, and the colour of the soil is light and reddish.

More recent in formation is the alluvial deposit, consisting of sand with overlying strata of mud, to be found in the valley of the Niger ; while along the coast is the great mangrove belt, in some parts over thirty miles in width. This area is intersected by the numerous mouths of the river and is being gradually built up by a deposit of silt brought down from the higher reaches and bound together by a dense growth of mangroves.

The nature of the vegetation varies in accordance with the different types of country described. In the delta the mangrove holds exclusive sway, while further up the river, and in the valleys where the air is more humid, there is a dense forest belt consisting of moderately large trees, thick low scrub and a tangled, impenetrable network of lianes and creepers. Further from the river are to be seen large trees with little undergrowth, while in the north-east and north-west the forest is of a deciduous type, and the country is consequently orchard-like and open. Scattered about in this last area are extensive stretches of tall elephant grass.

The main water-way in the Central Province is the Niger, the upper reaches of which I have described in a previous report.* This river enters Southern Nigeria near Idah and flows practically due south to Abo, where it breaks up into innumerable branches, some of which flow through the Central, and others through the Eastern Province, the whole forming the extensive region known as the Niger delta.

In the upper reaches it receives a considerable number of small tributaries. On the left bank the only one of any great importance is the Anambra River, which rises in Bassa Province in Northern Nigeria, and after flowing in a southerly direction enters the Niger near Onitsha. On the right bank the largest tributary is the Aseh River, which joins the Niger near Abo.

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* Bull. Ent. Res. II, pt. 4, pp. 315–318.

South of Abo the true delta of the Niger commences, and the various outlets to the sea have received definite names. The first of these to be navigated was what is known as the Nun entrance in the Eastern Province, but this channel has been abandoned for some time in favour of a larger one, which enters the sea at Forcados. Consequently, the Niger as a river navigable for large craft may be said to be almost entirely confined to the Central Province.

Most of the large ramifications in the delta area have been named after the chief towns which they pass, for example, the Benin River, the Warri River, the Forcados River and the Sapele River, while others are known as the Escravos River, the Ramos River and the Dodo River. These are all in the Central Province, but it must be remembered that they are in reality only creeks in the delta, which receive the subsidiary waters of the smaller streams in the Province, and are not in themselves distinct from each other.

The high lands of Ishan, Agbor and Kwale form a dividing line between the tributaries of the Niger which flow to the east and the numerous small streams which are directed westwards. Of the latter the most important is the Ovia River, which rises in the Kabba Province in Northern Nigeria, and, after flowing practically due south, pours its waters into the Benin River. Its chief tributary is the Ogbesse River, which rises in the Ilesha district in the Western Province, and enters the Central Province between Akure and Owo. The Osiomo River, which passes Benin City, also flows into the Benin River, and further east the Jameson River and the Ethiope River unite to form the Sapele River, which again in turn joins the Benin River. The River Warri rises in the Kwale district and enters the system of creeks near the town of the same name; this again joins the Forcados River before entering the sea.

It will thus be seen that the river-system of the Central Province is a very complicated network of creeks, fed chiefly by the Niger, but also to a certain extent by several small streams from the north-west. These creeks are connected with the series of lagoons in the Western Province which have been already described, and also with similar creeks in the Eastern Province, and it is thus possible to pass by launch from Badagri in the extreme West to Calabar and eventually to the Kamaruns without entering the open sea.

Politically, the Central Province is divided into 15 districts, each of which I now propose to discuss in turn as briefly as possible. For the present purpose, they may be conveniently divided into five groups, in accordance with the various types of physical configuration already discussed.

### (1) Ifon and Benin.

This region is comparable in many respects, and geographically is coterminous, with the Ilesha district in the Western Province. To the north and east of Ifon the country is open and hilly, while in the Kukuruku country, which extends into the Kabba Province of Northern Nigeria, it is very rocky. To the south and west there is extensive thick bush and large timber forests, which gradually merge into the Forests of Ondo, referred to elsewhere. Game is abundant. Elephant, leopard, buffalo, hartebeeste, waterbuck, duiker, harnessed antelope, wild pig and baboons are all said to occur. No tsetse have been recorded from this

region, but while at Ifon I saw several, though unfortunately was unable to secure specimens for identification. It is more than probable, however, that these were *Glossina longipalpis*, but they may have been *G. submorsitans.**

Two large rivers, the Owon and the Ovia and several small streams were crossed between Owo and Ifon, but no tsetse were seen at any of the fords. The only blood-sucking insect so far recorded from Ifon is *Tabanus besti* caught by Dr. R. W. Gray in December, 1910.

The most noteworthy feature in this district is the presence of large herds of a dwarf variety of cattle, which, according to native evidence, supported by a low rate of mortality, seems to be immune from trypanosomiasis. Throughout Northern Nigeria and in the parts of Southern Nigeria where cattle are found the predominant variety is of the Indian zebu type, usually white, with a large dorsal hump (Pl. II). A second variety, with a straight back, is also to be seen but in smaller numbers. These are all very susceptible to trypanosomiasis and readily succumb when introduced into a tsetse region. In the districts of Ondo, Ilesha, Ifon, Ishan in Southern Nigeria, and in the Kabba and Bassa Provinces of Northern Nigeria, all forested regions and tsetse habitats, this peculiar dwarfed variety with short legs may be seen in numbers. Their appearance is remarkable. The predominant colours are black and white, black, and, more rarely, brownish; there is no dorsal hump, and the forequarters are generally lower than the hind. The accompanying photograph (Pl. III) was taken by Mr. Sciortino, Assistant Resident in the Kabba Province, and gives a good idea of the build of these animals. Although this variety thrives well in the regions named, animals of either of the other types, immediately after being introduced, develop trypanosomiasis and die.

The goats in these districts are also short-legged and diminutive, and a dwarf variety of horse is said to be bred for use at Ondo. Imported horses at once succumb to trypanosomiasis.

*Benin.*—The country around Benin City, a very old and important town, is gently undulating, with a gradual slope to the sea. It is intersected by deep valleys, in each of which runs a small stream or river. Where not cultivated, the country is covered with a dense evergreen forest. The waterways connecting this region with the delta are very important, and, as they have a marked influence on the fauna, deserve some mention here. The Osiomo River (the lower part of which is known as the Olagi Creek), running into the Benin River below Koko Town, is fed by several branches, the Ogba, Ikpoba, Ohuma and Ohe Rivers. The Osiomo itself is navigable to Ologbo, about half-way between Benin City and Sapele, by launch, thence up to the Ikpoba by canoes to within 2½ miles of Benin City. The Ogba River is navigable by launch to Ogwosala, thence by canoe to Irishi, which is only four miles from Benin City. Sapoba is reached by launch on the Jameson River. The Ovia is navigable to a short distance below Ikoru for launches, and to a little below Gilli-Gilli for vessels drawing 12 to 13 feet.

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[* Mr. J. H. J. Farquhar has sent *G. palpalis* from Owo and Afuge in the Ifon District, and *G. longipalpis* from Ifon itself; while *Chrysops dimidiata* was obtained by him at Ojalla. These insects were taken in February and March, 1912.—Ed.]

At a small stream about 13 miles from Benin City, on the road to Ifon, I caught one *Glossina pallicera*, the only specimen of this species so far recorded from Southern Nigeria. In Benin City itself *G. palpalis* was caught in several places, including the Rest-house and the Hospital, while at the River Ikpoba, the water-supply of the town at the time of my visit, *Glossina caliginea* was far from common. *Stomoxys calcitrans* and *Stomoxys nigra* were also abundant, especially in the stables, and the dogs and cattle were infested with *Rhipicephalus sanguineus*. At Ologbo, on the River Osiomo, about midway between Benin City and Sapele, *Chrysops silacea*, *Tabanus billingtoni* and *T. thoracinus* were obtained, while Dr. R. W. Gray records *Glossina longipalpis* from a place about 15 miles north-east of Benin City, and *Chrysops silacea* (or *dimidiata*),* *Tabanus billingtoni*, *T. fasciatus*, *T. secedens* and *Glossina palpalis*, from Ohere not far from Benin City.

With regard to the districts of Benin City and Ifon he says :—

"So far as my experience goes the fly [tsetse] area is coterminous with the extent of these districts. I have not yet visited a place in either without noticing these flies. . . . I am of opinion that they deposit their larvæ at places other than those near streams. . . . Cattle live and breed in the district. They are to be met with in most or in all the villages. These cattle have a healthy appearance. There is a herd of cattle at Benin belonging to the Government. They are all in good condition and breed freely."

### (2) Sapele, Warri and Forcados.

The second group of districts may be considered as being almost entirely in the delta region. Warri and Sapele stand at the northern limit, and Forcados at the southern, or coast margin. The country around Sapele is for the most part low-lying and swampy, and is intersected by innumerable creeks forming a perfect system of water-transport. Ocean-going steamers can ascend to the town of Sapele. The mangrove forest extends for some 20 miles from the sea, and then gives way to forest land which is extensively farmed. A large amount of mahogany has been exported from this region. Cattle, goats and sheep are kept, but in small numbers. Leopard and antelope are said to occur in the denser bush ; crocodiles are abundant in the lower reaches of the Benin River and in the creeks near the sea.

*Sapele.*—*Glossina palpalis* has been caught at Sapele, but apart from this species the only blood-sucking insect so far recorded is *Chrysops silacea*. With reference to the bionomics of the latter species, I would draw attention to the following quotation from a letter received by me from Dr. Kelleher, who was stationed at Sapele for some time. "This fly appears at Sapele for a short visit twice yearly . . . It appears for a few weeks at a time at the beginning of the rains and at one other period which I am unable to fix. The natives in their tongue call it the 'softly-softly fly,' owing no doubt to its noiseless flight and gentle method of alighting. It usually hangs about the under parts of chairs and desks, and quietly and persistently flits to the ankles or the fingers, especially

* It is far from certain whether these two species are distinct.

if these are hanging down and not under care of the sight. By nature it is an out-door fly and only a short visitor to residences. It is more prevalent in the haunts of cattle. It does not attack people in the open, only in houses or closed canoes, and I think only in clear daylight, preferably the cool of the afternoon, after 3 p.m. It causes very considerable petty oedema of the part bitten, which does not disappear for a day or two, and sometimes bears a rough resemblance in size to 'Calabar Swellings.' When it is squashed while feeding, the contained blood is considerable."

*Warri.*—The country around Warri is very low-lying and exceedingly swampy in the rains ; in most places the paths used during the dry season are flooded and often impassable in the rainy season. The whole district is intersected by a net-work of rivers and creeks which are navigable for canoes and launches. Communication can thus be effected between Warri and such distant towns as Lagos, Forcados, Abo and Brass, the journey by water to the last-mentioned place being over 200 miles.

The natives belong chiefly to the Sobo and Ijaw tribes ; the former are more agricultural and inhabit the north and north-east, while the Ijaws are fishermen and live on the creeks in the south and south-west. All are of a very low class, unintelligent and of dirty habits, for which they can hardly be blamed considering the natural characteristics of the country in which they live.

*Glossina palpalis*, *Tabanus fasciatus*, *T. taeniola* and *T. secedens* swarm in all the creeks and backwaters.

*Forcados.*—Forcados is the principal shipping port of Southern Nigeria, and also the largest on the West Coast of Africa. No matter how efficient the railway system from Lagos may become, this township will always retain its position as the chief outlet for produce from both Northern and Southern Nigeria. It is now the headquarters of the Customs, Postal, Marine and Transport Departments of the Central Province, and the European population, both official and commercial, is increasing annually. Recently the Government removed their large engineering works from Akassa to Forcados and erected a slipway ; while a private firm owns a large dry-dock capable of taking ships up to about 2,000 tonnage. At present, there are over forty Europeans stationed permanently at Forcados, while the temporary European population as represented by the crews and stewards on steamers sometimes amounts to several hundreds. The native government staff, the employees of the various commercial firms, and the resident population exceeds two thousand.

The surrounding country is composed of swamps and a network of creeks. The town itself is situated on the left bank of the Forcados River about 8 miles from its mouth. Like Lagos, it is built on an island, which, prior to European occupation, consisted of an extensive mangrove swamp, and at the present time the greater part of it still remains in its original marshy condition. The town was created to meet a demand, and is purely artificial. The undertaking was an enormous and costly task and is yet far from complete. Drains had to be cut, roads had to be made, and before buildings could be erected the level of the ground had to be raised considerably. During the rainy season the whole island, with the exception of those raised parts, is under water, and the drains empty

and fill up with each fall and rise of the tide. The reclamation of land is slowly progressing and an extensive sea-wall is being built. When this is completed, and the level of the whole island raised a few feet by means of sand pumped from the sea, Forcados may then claim the title of a town. Sanitary work, so far as such is possible in the present conditions, is very efficiently carried on by the District Medical Officer, Dr. R. W. S. Smythe, but the total effect of keeping down mosquito breeding in native compounds is almost negligible in view of the enormous breeding-areas supplied by the omnipresent marshes. Nor is the drainage of these possible in the present conditions, and, except in a few cases, the employment of kerosene would be extremely expensive and almost useless.

Tsetse are everywhere to be found, and the number of mosquitos, both species and individuals, is enormous. These include *Myzomyia funesta* and *Stegomyia fasciata* in large numbers. Malaria is rife, and the possibility of yellow fever establishing itself in such a place is greatly to be dreaded. Recently a quarantine hospital was built on one of the creeks which flows into the Forcados River.

The Government of Southern Nigeria is fully alive to the necessity of reducing the amount of swamp on the island by means of a general elevation of the whole area, and no time should be lost in effecting this most urgent sanitary improvement. The risk to human life in the present state of affairs is the most cogent reason for advocating immediate and unceasing reclamation.

The following list of blood-sucking arthropods found in Forcados may exemplify more definitely the exact state of affairs :—*Glossina palpalis*, *G. caliginea*, *Tabanus fasciatus*, *T. par*, *T. secedens*, *T. socialis*, *T. taeniola*, *T. thoracinus*, *Banksinella luteolateralis*, *Ochlerotatus nigricephalus*, *Culex decens*, *C. insignis*, *C. invidiosus*, *C. rima*, *C. thalassius*, *Culiciomyia nebulosa*, *Myzomia costalis*, *M. funesta*, *Myzorhynchus umbrosus*, *Stegomyia africana*, *S. fasciata*, *Culicoides grahami*, *Ctenocephalus canis*, and *Rhipicephalus sanguineus*. One Muscid larva (probably *Cordylobia*) was taken from the breast of a European.

There are no large towns in the district. The natives are chiefly Ijaws, and live in small hamlets on the banks of the creeks ; their only industries are fishing and canoe-making.

Burutu is situated on the Forcados River a few miles above the town of Forcados. It is the headquarters of the Niger Company, and the Northern Nigerian Marine also have a station there. The mail-steamers ascend to this point for cargo and tie up alongside the wharf. The land is raised above the water-level, but is surrounded by mangrove swamp and dense bush, a large part of which ought to be cleared and the area drained. This "beach" is also a pestilential mosquito haunt, and most of the species obtained at Forcados were also found here. Between these two places the bank of the river is densely covered with mangrove (Pl. IV, fig. 1), and launches passing to and fro are invaded by swarms of *Glossina* and *Tabanus*. Nowhere in Southern Nigeria is there such a pressing need for systematic sanitary work as at these two places.

**(3) River Niger.**

The third group of districts in the Central Province comprises those through which the River Niger flows, and in order to form a narrative continuous with

the Northern Nigerian portion,* I have purposely started with the most northerly, namely, Idah. On the left bank the nature of the vegetation near the river is principally thick bush, but further inland it becomes more open, and the country is in parts very undulating and hilly. The town of Idah itself is situated on a cliff about 160 feet high. The vegetation on the right bank is very similar to that on the left, but inland the country develops a very hilly character, culminating in a range of hills running almost due north and south, known as the Kukuruku hills. The rivers draining this region all flow into the Niger, and include the Ofu, the Obe, the Ogio and the Orle. This district is said to be well stocked with game, including buffalo, water buck, hartebeeste and various other kinds of antelope. Goats and sheep seem to thrive, but cattle are far from common. *Glossina palpalis* and *Tabanus fasciatus* are the only two blood-sucking flies so far recorded from this region.

The Onitsha district is hilly and open; clumps of forest are met with only in the vicinity of towns and along the banks of rivers and creeks. It is well watered; the chief rivers are the Anambra, which flows from the north-east and enters the Niger above the town of Onitsha; other rivers are the Idi-Minni, the Orashi and the Oderiji. In addition to these there are innumerable streams containing, for the most part, excellent water. *Glossina palpalis* abounds along all these water-courses.

The larger mammals of the district include bush-cow, leopards, antelopes, hippopotami, and monkeys. There is a considerable number of the small breed of cattle referred to before, and these seem to thrive well, while goats and sheep are prolific; ponies die off soon after arrival. With regard to Onitsha, Mr. D. C. Price, District Commissioner, says:—"In 1903, the Government imported a herd of West Indian cattle—some 25 in all. They were put down at Onitsha and in little more than a year all were dead."

Between Illah and Onitsha both *Glossina palpalis* and *Tabanus subangustus* were caught on the steamer, while at Illah itself *Tabanus fasciatus* was obtained. At Abutshi, near Onitsha, *T. subangustus* has also been found. The most prevalent mosquito at the town of Onitsha was *Mansonioides uniformis*, but other species found were:—*Culex grahami*, *C. invidiosus*, *Culiciomyia nebulosa*, *Myzomyia costalis*, *M. funesta* and *Taeniorhynchus aurites*. A species of *Phlebotomus* was also troublesome; and numbers of *Auchmeromyia luteola* were caught. On the dogs, sheep and goats were numerous *Ctenocephalus canis*, *Rhipicephalus sanguineus* and *Haemaphysalis leachi*.

*Asaba.*—This is a purely agricultural district situated on the right bank. The interior has only recently been opened up and the headquarters transferred to Agwashi Oku. The main importance of the district lies in the fact that lignite has recently been found in such quantities and of such quality as to justify the Government making a metalled road from Asaba to a central point in the seam at Okpanam, eight miles out. Lignite has also been found in the north of Asaba district, between Okunzu and Ibu, and this may result in opening up this hitherto practically unknown country. Near Asaba *Glossina palpalis* and *Mansonioides uniformis* were obtained.

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* Bull. Ent. Res. II, pt. 4, p. 315.

*Abo.*—To the south of Onitsha and Asaba lies the district of Abo, where the true Niger may be said to end and the delta begin. The whole of the country is low-lying, and during the annual rise of the river a large portion is submerged. The Niger flows down the centre of the district and there are numerous streams, offshoots of the river, ramifying throughout the whole country; these are all navigable by canoe and many of them by launch. The country is well wooded, but, owing to the native system of continually clearing new ground for farms, none of the bush is of any great age and there is no primeval forest.

The main water-ways are the Niger and its tributary the Aseh River; the latter is navigable by launch only during the wet season. During the dry months paths connect most of the villages; of these paths those near the Niger are merely dried water-courses, but those on the West of the Aseh River and on the high ground in the north-east are passable all the year round. This district abounds in game; antelope, bush-cow, leopard and baboons are plentiful, while elephant have been seen; crocodiles and hippopotami are abundant in the river and creeks.

Sleeping sickness has been recorded from this district, while malaria, elephantiasis and filariasis are all common. The natives are good fishermen, and spend a considerable part of their time in canoes.

*Glossina palpalis* is almost universally distributed in the district, but is extremely abundant in the Aseh Creek. Specimens have been taken at Manunkor, Isilegu and Ebuka, the last two places being in the Aseh Creek. Other biting flies caught on or near the river in this region include:—*Tabanus fasciatus*, *T. secedens*, *T. taeniola*, *Rhinomyza stimulans* and *Glossina longipalpis*.

### (4) Kwale, Agbor and Ishan.

Removed from the Niger on the right bank are the districts of Kwale, Agbor and Ishan. Only one of these, namely Agbor, did I manage to visit, but the following notes will serve to indicate the nature of the country and its vegetation. Practically nothing is known of the entomological fauna of any of these districts.

*Kwale.*—The country is undulating, rising gently from Okpara in the south-west to Usonigbe in the north, with depressions in the valleys of the Ethiope and Ihimi Rivers. In the north-east, and in the region of the Ethiope River the country is dry, but the portion to the south of the Ihimi country is swampy. The Ethiope River is navigable from Sapele to Kokori waterside for launches, to Kwale for pinnaces, and to Obiariki for large canoes. The Ihimi River is not navigable; it is overgrown by dense foliage and is dry except in the rains. Game is said to be scarce.

*Agbor.*—This district is accessible either from Asaba, on the Niger, or from Sapele or Benin City, in the south. The country generally is undulating and there are no hills worthy of mention; it is badly watered. The vegetation is of a thick bushy character, which in parts carries heavy timber. The River Osiomo, on the eastern boundary, has recently been cleared and permits of large canoe traffic for the transport of produce to Sapele and Benin City. *Glossina palpalis* was obtained at the town of Agbor.

*Ishan*.—This country is undulating and badly watered; bush prevails over two-thirds of the district. The River Osiomo, in the south-west, and the Attowar, which rises at Ubiaja and joins the Niger at Illah, are navigable for canoes, the latter however only as far as Evua, a distance of some thirteen miles from Ubiaja.

Game is said to be abundant, and includes elephant, bush-cow, red river hog, kob, hippopotamus, roan antelope, bush-buck, water-buck and leopard. *Glossina palpalis* has been recorded from the district, but the information lacks preciseness.

### (5) Awka, Udi and Okwoga.

The last group includes the three above-mentioned districts, which all lie east and north of Onitsha.

*Awka*.—The country is undulating; in the north-east there are high hills and small plateaux. The towns are, as a rule, surrounded by bush, but the country between the towns is open. In the north there are extensive grassy plains and the area of bush diminishes. The only navigable water-ways are the Omerun River and the Anambra River.

"The domestic live-stock consists of cattle, sheep and goats. The cattle are a very good example of the African type, and some towns possess considerable herds. Goats are plentiful, but sheep scarcer. No definite evidence that tsetse-fly occurs is in existence, but the mortality amongst horses is probably due to it. Game is not plentiful. Hippopotami are found in the rivers and creeks in considerable numbers. Deer [sic] are to be found in the north. Bush-cow are found in fair numbers in the northern part of the district near the rivers." (H. N. Thomson.)

*Udi*.—The country is for the most part hilly, with open stretches covered with grass and patches of thick bush, in which the natives build their towns. These patches are generally from five to seven miles long and one to three miles wide (*cf.* the "kurimi" of Northern Nigeria). Various species of buck occur, and in the northern part elephant and leopard are to be found.

*Okwoga*.—This district has only recently been opened up, and little or nothing is yet known about it.

### (c) *The Eastern Province.*

The Eastern Province is situated to the south and east of the Central Province and extends inland from the Bight of Biafra to the southern boundary of Northern Nigeria. On the east it is bounded by the German Colony of Kamerun and on the west by the Central Province of Southern Nigeria. Its area is over 29,000 square miles, and it has a population of over two millions.

In the west the country is, generally speaking, flat and much intersected by creeks. The eastern portion is undulating, and in the extreme eastern part becomes hilly. From the sea-board up to about the sixth parallel the forest belt prevails, and thence northward grass country is met with.

This province has three distinct river systems although, as has been already pointed out, in the coast area these are connected by a system of creeks. The

south-west portion lies in the delta of the Niger, the central part is drained by several small rivers, of which the largest is the Opobo (known in the north as the Imo), while the eastern part is in the Cross River drainage area. The names of the principal rivers from west to east are, the Dodo, Pennington, Nun (mouth of the Niger), Brass, Sombreiro, New Calabar, Bonny, Opobo, Kwa Ibo, Cross, Calabar and Great Kwa Rivers.

The Calabar and the Great Kwa are tributaries of the Cross River and enter it near its mouth, while the only tributary of any great size further north is the Ewayon in the Aro Chuku District, about 150 miles from the town of Calabar.

For administrative purposes the Province is divided into twenty-one districts, and these we will proceed to consider in six more or less geographical groups.

### (1) Brass, Degema, Bonny and Opobo.

These four districts all lie within the eastern portion of the delta of the Niger, and commercially are very important. Large trading factories are situated throughout the various creeks and are reckoned the most unhealthy in Southern Nigeria, the percentage of malarial cases in this region being by far the highest for any part of the Colony. Within recent years enormous improvements have been made, more especially on the Government "beaches," but the state of clearing and general measures for the reduction of the number of mosquitos at most of the trading stations leaves much to be desired.

I was enabled to travel by launch for over a fortnight, visiting the various stations in this region, and Dr. Collett, who was stationed at Opobo during my visit, but who was afterwards transferred to Degema, has also collected and sent to England a large number of specimens of the various blood-sucking insects at these places.

The following short descriptions of the districts and the lists of insects found at the different parts will serve to show how prolific this region is in potential disease-carriers.

In the Brass District, the country is chiefly swamp, intersected by a regular network of creeks, and communication is effected between the various villages by launch or canoe. It is estimated that there are not over twenty miles of path in the district, and even these tracks are fit for use only during the dry season. Monkeys, hippopotami and crocodiles are almost the only large animals in this region, though elephant are occasionally seen. Cattle, sheep and goats are extremely rare.

The town of Akassa was, until recently, very important, but the marine engineering works which formerly existed there have now been removed to Forcados. Akassa is on the sea-coast and is accessible by ocean-going steamers.

*Tabanus secedens*, *T. socialis* and *T. thoracinus* are all common, while the mosquitos *Myzomyia costalis* and *Stegomyia fasciata* constitute a perfect pest. On the launch and even in the houses it was almost impossible to sit in the evening without having recourse to a mosquito-proof room.

The town of Brass is situated a short distance up one of the creeks, and here also the above-named insects were abundant, while *Glossina palpalis* was an additional scourge.

The greater part of the Degema district is composed of mangrove swamp, but in the northern portion there is some good high ground. This region is a bewildering maze of creeks, but wherever there is any solid ground one sees a small fishing hamlet and a few coconut palms. There is no attempt at agriculture, as the only parts above high water mark are occupied by huts. These hamlets swarm with noxious insects of all kinds, e.g., *Tabanus secedens*, *T. socialis*, *T. thoracinus*, *Glossina palpalis*, and *Stegomyia fasciata*; probably many more would be found if a thorough examination were made.

At the town of Degema, the following mosquitos, in addition to those mentioned above, were obtained, *Myzomyia costalis*, *Culex duttoni*, *C. tigripes* var. *fuscus*, *C. invidiosus*, *Ochlerotatus domesticus*, *O. nigricephalus* and *Taeniorhynchus annetti*.

Bonny is a small district comprising the port and island of Bonny. The country is all in the delta belt and is consequently very flat and swampy with occasional tracts of firm land. A considerable amount of reclamation has been done around the town and much low-lying ground has been raised, but this work is yet far from complete. Bonny is a regular port of call for mail boats, and all officials and others for the area under discussion trans-ship here. Consequently, it merits considerable attention from a sanitary standpoint. *Myzomyia costalis* and *Stegomyia fasciata* are both extremely abundant, as also is *Ochlerotatus nigricephalus*. Sand-flies are said to be very troublesome during the rains, but none were seen during my visit in the month of May.

The district of Opobo lies to the east of Bonny around a river of the same name, which rises in the hinterland, where it is known as the Imo. It is connected by creeks, however, with the Niger delta area, though topographically distinct from it. There is a regular launch service through these creeks between Bonny and the town of Opobo, the headquarters of the district at the mouth of the Opobo River. Near the coast, the land is covered with mangrove swamp intersected by occasional patches of sandy soil; further inland, in the north and east, the country is undulating; in the west it is very low-lying and swampy during the rains.

Cattle, sheep and goats are kept, but in small numbers. Elephant, hippopotami, crocodiles, antelope and pig are to be found in the Andoni portion of the district—a marshy stretch of country near the sea.

On the launch, between Bonny and Opobo, the following blood-sucking insects were found :—*Glossina palpalis*, *Tabanus secedens*, *T. socialis*, and *T. thoracinus*; while at Opobo itself, in addition to these, *Tabanus argenteus*, *Chrysops longicornis*, *Culex guiarti*, *Culiciomyia nebulosa* and *Stegomyia fasciata* were obtained. Similarly, during the journey by launch up the river Opobo to Akwete *Tabanus secedens*, *T. socialis* and *Glossina palpalis* flew aboard in numbers, while at the latter place *Tabanus obscurehirtus* and *Chrysops silacea* were caught.

The districts of Ahoada and Owerri lie north of a line drawn from Akwete and Degema, being inland from the delta, but in the basin of the Niger. During my visit to the colony I was unable to visit either of these regions, and so far no blood-sucking insects have been received from them. The following short description will, however, serve to show the nature of the country.

The whole district of Ahoada is flat and low; it lies between two rivers and is very swampy in the wet season. In certain parts, however, stretches of long grass are found as well as forest. Much of it is comparable to the "fadama" of Northern Nigeria, in which water lies to a depth of nearly six feet in the wet season, but which, during the dry season, is baked hard and cracked by the sun. The main river is the Sombreiro, which is navigable by launch as far as Ihoaba at all times of the year, by canoe during the rains to the source of the Nkissi River, and in the dry season at least to Ikri. Leopards, bush-cow and antelope are not uncommon, while elephant are occasionally encountered in the Anenzoh country.

The district of Owerri is flat and sandy, and is covered for the most part with thick low bush. Goats, sheep and cattle are kept, but horses do not thrive. Buck of various sorts are common, as also are leopards, while hippopotami are occasionally seen near Oguta.

### (2) Eket.

To the east of Opobo is the district of Eket on the Kwa-Ibo River. This river, like the Opobo, rises some distance from the coast and is independent of either the Cross River or the Niger, that is, it pours its waters direct into the sea near the town of Eket. The southern half of the country is low-lying, wet and swampy, and covered with virgin forest. This part is practically uninhabited, and, except on the coast where fishing huts are to be found at intervals, no natives exist. The remainder of the district is covered with low bush cut every few years for cultivation.

Capt. L. E. H. Humfrey, District Commissioner in S. Nigeria, was stationed here for a short time and found the following blood-sucking insects:—*Tabanus secedens*, *T. socialis*, *T. obscurehirtus*, *T. obscurefumatus* and *Chrysops silacea.* With the exception of these records the entomology of this district is absolutely unknown.

### (3) Aba, Ikot-Ekpene, Bende and Okigwi.

The districts in the next series are all inland, being situated between the Niger and the Cross River.

The most southerly is Aba, which lies on the river of the same name, a tributary of the Opobo, while Okigwi, the most northerly, is situated at the head waters of the River Opobo, known in its upper reaches as the Imo. The Bende district is not far from the head of the Enyong Creek, a tributary of the Cross River, while Ikot-Ekpene also lies in the basin of the same river.

*Aba.*—Around Aba the country is flat, for the most part waterless, and covered with low scrub or else under cultivation. Groups of large trees at market-places serve to show how dense must have been the forest at one time. A large navigable river, the Imo, forms the western boundary; the Aba River flows through the central part of the district, and the Achacha River, which joins the Kwa-Ibo River near Itu, forms the eastern boundary. These rivers form practically the only water-supply of the district, Goats, sheep, pigs and dogs are common, but horses do not thrive. Leopards, antelopes and monkeys are to be found in the district.

Not far from Akwete, on the Opobo River, *Glossina palpalis* occurs, while in the drier regions *Chrysops silacea* is not uncommon. At the town of Aba, in addition to the latter species, only one blood-sucking insect was seen, namely the mosquito *Myzomyia pitchfordi*, a by no means common species.

*Ikot-Ekpene.*—"The country on the right bank of the Enyong River, extending about 12 miles inland, consists of a succession of hills rising gently from narrow valleys watered by several small streams, choked with palms and other vegetation, and swampy in the wet season. The height of these hills is 200–350 feet. The rest of the district is a tableland, elevated about 200 feet above sea level, broken by the valley of the Kwa-Ibo River, four miles west of Ikot-Ekpene and by that of the Achacha River on the western boundary. All over the district, except for a narrow fringe along the right bank of the Enyong, the original forest has long ago been cleared away for cultivation, and the only large trees remaining stand in town places, burial groves and market-places. The whole country is a patchwork of fields, in various stages of fallowness, clumps of bushes with tall grass and herbage growing between. The sub-soils are loam and sand on a base of sedimentary rock. During the dry season (November to March) water is extremely scarce in the southern and central parts—no village, however, is more than a few hours' walk from some stream. There is nowhere any collection of huts large enough to be called a town; each village community consists of a number of isolated family compounds, separated from one another by groves of bush and small patches of crops."

No TABANIDAE, *Glossina* or Anophelines were seen during a week's stay in this district, but Culicines were very abundant. The following species were found :—*Culex duttoni*, *C. grahami*, *C. insignis*, *C. tigripes* var. *fuscus* and *Culiciomyia nebulosa.* The only other blood-sucking insect obtained was *Ctenocephalus canis*, but *Culicoides* is said to be very troublesome during the rains.

Near the European quarters there is a large swamp which constitutes the main breeding-ground for mosquitos, but the abolition of this within a short period is almost impracticable without an enormous outlay. A certain amount of work has already been accomplished, which has resulted in the area being considerably diminished. Both the political and medical officers on the station are fully alive to the necessity of a still further reduction, and it is to be hoped that an annual grant may be voted to carry on the work so efficiently begun. In the pools of water in this swamp large numbers of a small fish, *Hemichromis fasciatus*, belonging to the family CICHLIDÆ, abounds. Mr. G. A. Boulenger in a letter to me with regard to this species says "This fish, known to take a fly, must, in my opinion, be a good mosquito-larvae destroyer." Every effort should therefore be made to prevent its destruction.

*Okigwi.*—The Okigwi district lies at the head of the River Imo and is consequently in the same river system as Opobo and Owerri. The country is covered for the most part with thick bush, but scattered about are open patches, while in the north it is very hilly, with rolling grass plains. Near the River Imo there are extensive swamps during the rains.

This region I visited during the dry season, when insect-life was far from plentiful. No biting flies were seen at the station of Okigwi, but in a large

swamp, about nine miles away on the road to Afikpo, the source of the River Ivo, which flows into the Imo, *Glossina palpalis* and *Hippocentrum trimaculatum* were abundant. At Ishiago, on the River Ivo, the same two species, along with *Tabanus secedens*, were taken, while, at this place also, jiggers (*Dermatophilus penetrans*) were a perfect scourge in the native-built rest-house. So abundant were they that in a small space on the ground dozens could be seen hopping about. The carriers suffered badly and for days afterwards kept continually extracting them from their feet. One man assured me that he took twenty-seven from one foot. The only remedy in such a case is the complete destruction of the house by fire. This I recommended to the Medical Officer of the district.

*Bende.*—This district lies in the drainage area of the Cross River. The country throughout is undulating and broken and is covered with light bush of the savannah-forest type, except near the water-courses, where it is very dense. At the time of my visit (May 1910), by far the commonest blood-sucking fly was *Hippocentrum trimaculatum*. In addition to those species seen by the writer, and two sent by Dr. Wilson, Dr. P. H. Macdonald made exhaustive collections, and from these sources the following list has been drawn up :—*Glossina palpalis*, *G. fusca*, *Chrysops silacea*, *Hippocentrum trimaculatum*, *Tabanus besti*, *T. kingsleyi*, *T. par*, *T. taeniola*, *T. williamsi* (one specimen), *Culex decens*, *C. duttoni*, *C. tigripes* var. *fuscus*, *Culiciomyia nebulosa*, *Eretmopodites leucopus*, *Mansonioides uniformis*, *Stegomyia africana*, *S. apicoargentea*, *S. fasciata*, *S. luteocephala*, *Myzomyia costalis*, *M. funesta*, *Culicoides grahami*, and *Ctenocephalus canis*. *Cordylobia anthropophaga* and *Auchmeromyia luteola* have also been recorded from this station, while *Haemaphysalis leachi* was found on a pig and *Rhipicephalus sanguineus* on a leopard.

Dr. Wilson, in forwarding specimens of *Glossina palpalis* and *Chrysops silacea*, wrote :—"These two flies are very common in the station. Both were caught in the dispensary. The *Chrysops* is a vicious biter."

Dr. Macdonald has also kindly supplied the following notes :—

"Sand-flies (*Culicoides grahami*) are a very great pest in this station and bite severely from 4.30 p.m. until dark. They also bite in the morning, but the number then is very small compared with that at evening-time. After one has bitten a well marked wheal is left, which itches intensely for a few minutes, and sometimes the itching lasts for several hours, though of course less severe than that of the first few minutes after the bite. In April they first became troublesome and are at their height now (August). There is a small spring, about 200 yards from the bungalow, and from about 4.30 p.m. they are very troublesome there. They are not so numerous at the bungalow, but still extremely troublesome, about 10–15 settling on one in five minutes. Clearing and drainage of the land around the bungalow seems to have had no effect in the reduction of numbers. The native name for them is "Atita." One European who lived here was perfectly indifferent to them and they caused him no annoyance whatever."

Goats, sheep and pigs seem to thrive quite well at Bende, but horses all die soon after importation. Leopard, bush-cow and several varieties of antelope are to be found in the vicinity of the station.

From Ikpe, about 20 miles from Bende, *Chrysops silacea*, *Hippocentrum trimaculatum*, *Culex duttoni* and *Mansonioides uniformis* have been recorded.

### (4) Abakaliki, Ogoja and Obudu.

These three districts have only very recently been opened up, and practically nothing is known either of the physical features of the country or its fauna. According to the official report for 1910 the country is for the most part covered with grass and small trees; there is very little bush, and that only along the rivers and streams. Cattle, sheep and goats are to be found in fair numbers. Horses are often brought in from the north and north-west but inevitably die in the wet season. Elephant are said to be plentiful in the north, while leopard, bush-cow, kob, and duiker are fairly abundant. The district of Obudu has been in the hands of the Civil Authorities only since the end of 1909.

*Ogoja.*—" The district is divided by the Auja River; that part of the district on the left bank of the river is broken and hilly in parts. There are patches of thick bush, chiefly on the river and creek banks; the remainder is grass country covered lightly with short stunted trees. This part of the district has numerous permanent streams running through it. In parts the country is very stony, chiefly ironstone and hard sandstone, with grey granite in the eastern part of the district. On the right bank of the Auja River, the type of country is totally different from that on the left, it being for the most part open, level, grass country, the only bush being that around the towns, and a little on the banks of the river and streams. Although the country is so flat, it is well watered by permanent running rivers, the largest being the Onwu. The grass in the wet season grows very high.

" The live-stock are cattle (a small breed), sheep, goats, swine, dogs, fowls and ducks. Horses are reported to be bred in the Munshi country, 15 miles north-east of Ogoja. The few horses already brought into the district appear to do well, although the tsetse-fly is very prevalent.

" Wild animals are plentiful, viz. :—bush-cow, hippopotami, water-buck, cob, crocodiles, porcupines, a large variety of small antelope, hares, leopards, and civet cats. Elephants and rhinoceros are reported to be in large numbers to the east of Ogoja, about 25 miles distant, which forest is said to be teeming with big game of all sorts."

Mr. M. H. Corsellis, the District Commissioner at Ogoja, writing in November 1910, said that both *G. palpalis* and *G. morsitans* had been found in the district. He also added that both horses and dogs had died of trypanosomiasis and that trypanosomes had been found in the blood of these by the District Medical Officer.

### (5) The Cross River.

*Ikom.*—The country to the north and north-east of this district is well-watered and covered with dense forest; to the west it is undulating and covered with grass; to the south and south-east it is hilly with numerous farms in the valleys. The whole country abounds in game. Elephant, leopard, bush-cow, water-buck and kob are very common, while in the river hippopotami, manatee and crocodiles are plentiful.

During my stay at Ikom I saw many trees, especially " Flame of the Forest " (*Flamboyia regia*), damaged by the larvae of beetles. These species have been identified as *Coptops fusca* (Fam. LAMIIDAE) and *Lagria sp.* (Fam. LAGRIIDAE).

In addition to the species of blood-sucking flies obtained by the writer, Dr. W. S. Clark and Mr. E. Dayrell have sent a number of species, and the following list has been compiled from these sources. At Obokum on the Cross River, near the German frontier, *Tabanus besti*, *T. marmorosus*, *T. obscurehirtus*, *T. ruficrus* and *T. secedens* are common; while from Ikom station the following species have been recorded :—*Glossina palpalis*. *G. fusca*, *G. tabaniformis*, *G. tachinoides*, *Subpangonia grahami*, sp. n. (see p. ), *Tabanus fasciatus*, *T. obscurissimus*, *T. ruficrus*, *T. taeniola*, *Chrysops silacea*, *Haematopota cordigera*, *Hippocentrum trimaculatum*, *Mansonioides uniformis* and *Myzomyia costalis*. *Rhipicephalus sanguineus* is very common on the cattle, sheep, goats and dogs.

I traversed the whole of the Cross River from Ikom to Calabar by launch and obtained an enormous number of biting flies by this means. The accompanying photographs (Pl. IV, fig. 2 and Pl. V) will serve to give some idea of the nature of the banks of this river during the dry season. In the rainy season the level of the river ascends to the top of the banks, a distance of over forty feet in some places where the river is narrow (Pl. V, fig. 2).

The portion of the river between Ikom and Obubra was undoubtedly the worst haunt of *Glossina palpalis* seen by me in Southern Nigeria, and is comparable only with the Bintang Creek in the Gambia.* Besides this species the following were also abundant :—*Tabanus fasciatus*, *T. ruficrus*, *T. taeniola* and *T. combustus*.

*Obubra.*—Southwards from Ikom is the district of Obubra. It is very hilly and full of deep ravines, stony in places, but fertile, except in the Ikwe country, which is very swampy. Cattle, sheep and goats are kept by the natives, and a few horses exist near the northern boundary. The game is very similar to that at Ikom. In and around the station of Obubra the following species of blood-sucking flies have been caught :—*Tabanus fasciatus*, *Subpangonia gravoti*, *Haematopota cordigera*, *Mansonioides uniformis*, *Myzomyia funesta* and *M. costalis*. *Rhipicephalus sanguineus* is very troublesome to cattle, sheep and goats. Between Obubra and Afikpo the following species were caught on board the steamer :—*Glossina palpalis*, *Tabanus fasciatus*, *T. secedens*, *T. taeniola* and *T. thoracinus*, while near Ediba Beach *Tabanus combustus* and *T. besti* were obtained.

*Afikpo.*—The district of Afikpo is situated on both banks of the Cross River. On the left bank the country is thickly forested, but on the right it is open, grassy and very undulating, gradually merging into the rolling grassy plains and hills of Okigwi. On the road from Okigwi to Afikpo, *Glossina palpalis* was caught at the Iziarka River; between this river and the town of Eke-Ada the same species was encountered along with *Hippocentrum trimaculatum*, while between Eke-Ada and Afikpo only the latter species was seen.

The station of Afikpo is situated on a high hill over a mile from the river. At the base of this hill there is a large swamp which is a powerful local fetish. This swamp is a pestilential breeding-place for mosquitos. Some difficulty has

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* Bull. Ent. Res. II, pt. 3, p. 209.

been experienced by the authorities in having this area drained or filled in, and the native feeling is so strong that for the present the idea has to be abandoned. It is to be hoped, however, that soon this prejudice will be overcome, to the lasting good of the European quarter. This station has the unenviable reputation of being almost, if not quite, the most unhealthy in Southern Nigeria. The present situation of the European bungalows is in the direct line of the prevailing wind which blows over the swamp mentioned. The bungalows are continually infested with mosquitos, and the following species are extremely abundant:—*Myzomyia funesta*, *M. costalis*, *Mansonioides uniformis*, *Culex grahami* and *Culiciomyia nebulosa*.

On the steamer between Afikpo and Itu numerous specimens of the following species of blood-sucking flies were obtained:—*Glossina palpalis*, *Tabanus fasciatus*, *T. secedens*, *T. socialis*, *T. taeniola* and *T. thoracinus*. At the town of Itu *Chrysops silacea*, *Tabanus secedens* and *Glossina palpalis* have been caught.

*Aro-Chuku.*—Nearly the whole of this district is undulating and broken, and a large part of it is under water during the wet season. On the right bank of the river the bush is thin and there is a fair amount of cultivation, but on the left the bush is much more dense and the country is practically uninhabited. Goats are almost the only domestic animals kept, and game is scarce.

*Uyo.*—South of Aro-Chuku is the district of Uyo. The centre is flat, the east is hilly, but towards the west the country is open and extensively cultivated. The bush contains many oil-palms; it is very thick on the banks of the river and creeks and in the west and south-west portions of the district. There are no horses and cattle; sheep and goats are scarce; none of them are bred systematically. Hippopotami and crocodiles are to be found in the river, but inland there are only a few harnessed antelope, leopard, pig, wild cats and monkeys.

From Odut on the left bank of the river *Tabanus subangustus* and *T. obscurefumatus* have been recorded.

*Calabar.*—The whole district is hilly, but there are no very marked ranges. The country is densely covered with forest, thickest in the north-west near Uwet, and least in the north-east or Akpaboyo country, where there is a considerable amount of cultivation. In the southern part, towards the German frontier and the sea, there is an extensive mangrove belt intersected by numerous creeks.

The town of Calabar is large and important; it is the headquarters of the Eastern Province and a busy seaport. The only Tabanids actually seen within the precincts of the town were *T. socialis* and *Chrysops silacea*, and though the number of different species of mosquitos was comparatively large, the actual number of individuals was far from excessive—a fact which says much for the systematic prophylactic measures inaugurated by the Senior Medical Officer. The following species were obtained:—*Myzomyia costalis*, *Culex insignis*, *C. rima*, *Culiciomyia nebulosa*, *Ochlerotatus domesticus* and *Hodgesia sanguinis*. The occurrence of the last-named species is remarkable, as, prior to this, the only other locality from which it has been recorded is Entebbe, the capital of Uganda.

*Glossina palpalis* is frequently met with in Calabar; this is due in great part to the large amount of dense bush on the face of the cliff separating the town from the river. Dr. Chichester has time and again condemned this and urged its removal, and it is to be hoped that soon this will be accomplished.

Capt. Rojas of the Southern Nigeria Marine captured several specimens of *Tabanus secedens* and *T. fasciatus* during a trip up the Calabar River to Uwet, and informed me that both these species are everywhere abundant on the river. *Tabanus combustus* has also been recorded from Uwet.

During my visit to this region, I had an opportunity of examining both the Henshaw Creek, which joins Calabar and the Kwa River, and also the Ikang Creek, which leads through to the German frontier. Both these creeks are very narrow, in fact, it is difficult for a small launch to turn in either of them; the ground is muddy and the vegetation is dense; the air is musty and damp; and altogether they are pestilential passages. In Henshaw Creek *Tabanus secedens*, *T. besti*, and *Glossina palpalis* were a source of great annoyance, while during the day in the Ikang Creek the same three species, together with *Glossina caliginea*, kept one continually on the alert. It was my misfortune to have to anchor in the latter creek over-night, and never did I see such swarms of mosquitos (*Myzomyia costalis*). From five o'clock onwards, these attacked unrelentingly, and as the launch was small, it was impossible to have one's bed put up early. Consequently, every attempt to do so and at the same time exclude mosquitos ended in absolute failure. It is no exaggeration to say that there were thousands of these in the small cabin persistently throughout the whole night. The fact also that an anchor-light was essential attracted more and more, and the native sailors, who are generally oblivious to a reasonable number, spent the whole night, like the writer, moving about and trying, though unsuccessfully, to reduce the number of voracious onslaughts.

The following are some further records of blood-sucking insects from the Cross River area:—

At the mouth of the river—*Tabanus obscurehirtus.*

Stubbs Creek—*Tabanus socialis* and *Chrysops silacea.*

Awa Creek—*Chrysops silacea.*

At Ndogolai—*Chrysops dimidiata.*

Dr. R. W. Gray has also sent specimens of *Culicoides grahami*, *Phlebotomus duboscqi* and *Simulium damnosum*, from the Cross River region, but without any definite data or localities.

### (6) Oban.

This district lies to the east of the Cross River, at the foot of the Kamerun mountains. In physical characteristics it is quite different from any other region in Southern Nigeria, and on this account, and also from the fact that it is the meeting-place of the great Congo Forest with the belt which stretches up the West Coast, the fauna is peculiarly interesting and would well repay investigation.

Unfortunately, the writer was unable to visit this region during his tour in Southern Nigeria, but the following description is based on the official report for that colony, while, for the few insect records, we are indebted to Mr. J. H. J. Farquhar, Provincial Conservator of Forests in the Colony.

"The district is a mass of hills, interspersed with valleys, ravines and rivers. Everywhere loom up the granites, schists and gneisses of the ancient Oban rocks, rising 3,000 feet high, some of them extraordinarily picturesque and grand for their size. Except to the south of Oban there is hardly a level spot. The main water-shed stretches across the country from east to west at about the latitude of 5° 30′, north of which the streams flow into the Cross River, and to the south combine to form the Calabar, Kwa and Akwayafe Rivers. Many of the largest rivers rise on opposite sides of the same hill, such as the Calabar and the Kwa, the Akwayafe and the Akarram. None are navigable within the district except the lower reaches of the Kwa. With the exception of the village clearings and a few farms, hidden away here and there, the country is covered with dense forest—the Ekoi Forest.

"The rainy season lasts from May to November, and the annual rainfall is exceptionally heavy, probably well over 150 inches. Travelling in the northern parts is arduous owing to the rocky ground and to the fact that the paths go up and down over hills 1,000 and 2,000 feet high.

"Hunting is the chief occupation of the people. The men are splendid hunters and many of them devote all their time to the chase. Each town has its own special part of the bush reserved for its inhabitants."

The district abounds in game of all kinds. Elephants roam about in large herds, especially in the rainy season, generally retiring to the Kameruns in the dry season. Lions are said by the natives to come sometimes down as far south as this in pursuit of game; leopards are everywhere. The forest is full of bush-cow, water-buffalos, wild pig, many kinds of antelope, such as the harnessed antelope, the smaller bush-buck, the black-backed and yellow-backed duiker, baboons, etc., etc. Malaria, elephantiasis, and dysentery are very common. The only blood-sucking insects so far recorded from this region are *Chrysops silacea*, *Tabanus fasciatus*, *T. obscurefumatus*, *Glossina fusca* and *G. tabaniformis*, in addition to a new species of *Tabanus* not yet described; but this is undoubtedly far short of the actual number.

A systematic examination of this region would certainly reveal many rare species, in fact, from the five recorded above, one, *T. obscurefumatus*, has not been recorded from elsewhere in Southern Nigeria, while the only other locality in which *G. tabaniformis* has been found is Ikom, which is part of the same topographical unit. Here we might expect to find an intermingling of the true Congo forms with the undoubted Coast forms.

## IV. Records of Blood-sucking Insects and other Arthropods from Southern Nigeria.

The records of the various blood-sucking insects and ticks found in Southern Nigeria have been detailed in the preceding pages in connection with the different regions discussed. At the same time it is considered advisable to tabulate these in their orders and families, as hitherto no complete list has been attempted. It will be seen from this list that our knowledge of the species of this region has considerably increased, even since the publication of Austen's "African Blood-Sucking Flies" in 1909, while a study of the narrative in this report will serve to show the enormous advance made in our knowledge of the distribution of the various species.

It must not be supposed that this list by any means exhausts the species to be found in Southern Nigeria; in fact several forms at present await description and undoubtedly many more will be found, especially perhaps in the north and east of the Eastern Province. Further, it must be noted that much has yet to be learnt as regards the distribution of all the species here recorded; in fact, in most cases the records are so scanty that it would be inadvisable to enter into any discussion as to their general distribution. It is to be hoped, therefore, that this list may be taken only as a guide as to what has been accomplished and that the narrative may help to show how inadequate our information is, and so stimulate others to collect even the most common species from every available locality, in order that eventually we may be able to map out the distribution of each.

## Order DIPTERA.

### Family Culicidae.

*Aëdomyia catastica*, Knab.
*Banksinella luteolateralis*, Theo.
*Culex annulioris*, Theo.
„ *consimilis*, Newst.
„ *decens*, Theo.
„ *duttoni*, Theo.
„ *grahami*, Theo.
„ *guiarti*, Blanch.
„ *insignis*, Carter.
„ *invidiosus*, Theo.
„ *ornatothoracis*, Theo.
„ *pruina*, Theo.
„ *quasigelidus*, Theo.
„ *rima*, Theo.
„ *thalassius*, Theo.
„ *tigripes*, Gr. var. *fuscus*, Theo.
„ *univittatus*, Theo.
„ *zombaensis*, Theo.
*Culiciomyia nebulosa*, Theo.
*Eretmopodites inornatus*, Newst.
„ *leucopus*, Graham.
„ *quinquevittatus*, Theo.
*Hodgesia sanguinis*, Theo.
*Ingramia nigra*, Theo.
„ *uniformis*, Theo.
*Mansonioides uniformis*, Theo.
*Micraëdes inconspicuosus*, Theo.
*Mimomyia mimomyiaformis*, Newst.
„ *plumosa*, Theo.
*Mucidus mucidus*, Karsch.
*Myzomyia costalis*, Loew.
*Myzomyia funesta*, Giles.
„ *marshalli*, Theo.
„ *pitchfordi*, Power.
„ *nili*, Theo.
*Myzorhynchus mauritianus*, Gr.
„ *paludis*, Theo.
„ *umbrosus*, Theo.
*Nyssorhynchus pharoensis*, Theo.
*Ochlerotatus caliginosus*, Grah.
„ *domesticus*, Theo.
„ *irritans*, Theo.
„ *longipalpis*, Grünb.
„ *marshalli*, Theo.
„ *nigeriensis*, Theo.
„ *nigricephalus*, Theo.
„ *punctothoracis*, Theo.
*Stegomyia africana*, Theo.
„ *apicoargentea*, Theo.
„ *fasciata*, F.
„ *luteocephala*, Newst.
„ *sugens*, Wied.
*Taeniorhynchus annetti*, Theo.
„ *aurites*, Theo.
„ *cristatus*, Theo.
„ *metallicus*, Theo.
*Toxorhynchites brevipalpis*, Theo.
*Uranotaenia annulata*, Theo.
„ *balfouri*, Theo.
„ *coeruleocephala*, Theo.
„ *mashonaensis*, Theo.
„ *mayeri*, Edw.

### Family Tabanidae.

*Chrysops dimidiata*, Wulp.
„ *longicornis*, Macq.
„ *silacea*, Aust.
*Haematopota cordigera*, Bigot.
„ *decora*, Walk.
„ *tenuicrus*, Aust.
*Hippocentrum trimaculatum*, Newst.
„ *versicolor*, Aust.
*Rhinomyza stimulans*, Aust.
*Subpangonia gravoti*, Surc.
„ *grahami*, Aust.
*Tabanus argenteus*, Surc.

Family TABANIDAE—*cont.*

*Tabanus besti*, Surc.
" *biguttatus*, Wied. var. *croceus*, Surc.
" *billingtoni*, Newst.
" *combustus*, Big.
" *ditaeniatus*, Macq.
" *fasciatus*, F.
" *kingsleyi*, Ric.
" *laverani*, Surc.
" *marmorosus*, Surc.
" *obscurefumatus*, Surc.
" *obscurehirtus*, Ric.
*Tabanus par*, Walk.
" *pluto*, Walk.
" *quadrisignatus*, Ric.
" *ruficrus*, P. de B.
" *secedens*, Walk.
" *socialis*, Walk.
" *subangustus*, Ric.
" *taeniola*, P. de B.
" *thoracinus*, P. de B.
" *williamsi*, Aust.
*Thaumastocera akwa*, Grünb.

Family MUSCIDAE.

*Auchmeromyia luteola*, F.
*Cordylobia anthropophaga*, Grünb.
*Glossina caliginea*, Aust.
" *fusca*, Walk.
" *longipalpis*. Wied.
" *medicorum*, Aust.
" *nigrofusca*, Newst.
" *pallicera*, Bigot.
*Glossina palpalis*, Rob. Desv.
" *tabaniformis*, Westw.
" *tachinoides*, Westw.
*Stomoxys brunnipes*, Grünb.
" *calcitrans*, L.
" *nigra*, Macq.
" *omega*, Newst.

Family CHIRONOMIDAE.

*Culicoides distinctipennis*, Aust.
" *grahami*, Aust.
" *milnei*, Aust.
*Ceratopogon castaneus*, Walk.
" *inornatipennis*, Aust.

Family SIMULIIDAE.

*Simulium damnosum*, Theo.

Family PSYCHODIDAE.

*Phlebotomus duboscqi*, Nev.-Lem.

Family HIPPOBOSCIDAE.

*Hippobosca maculata*, Leach.

Order SIPHONAPTERA.

Family PULICIDAE.

*Ctenocephalus canis*, Curtis.
*Xenopsylla brasiliensis*, Baker.
*Xenopsylla cheopis*, Roths.

Family SARCOPSYLLIDAE.

*Dermatophilus penetrans*, L.
*Echidnophaga gallinacea*, Westw.

Order ANOPLURA.

Family HAEMATOPINIDAE.

*Linognathus africanus*, Kell. & Paine.

Order RHYNCHOTA.

Family CIMICIDAE.

*Cimex rotundatus*, Sign.

Order ACARI.

Family IXODIDAE.

*Amblyomma nuttalli*, Dön.
" *variegatum*, F.
*Boophilus decoloratus*, Koch.
*Haemaphysalis leachi*, Aud.
" *parmata*, Neum.
*Hyalomma aegyptium*, L.
*Rhipicephalus neavei*, Warb.
" *sanguineus*, Latr.
" *simpsoni*, Nutt.
" *simus*, Koch.
" *sulcatus*, Neum.

## V.—Insect-borne Diseases in Man and other Animals.

### Malaria.

As in all West African Colonies, malaria is by far the most prevalent insect-borne protozoal disease, but owing to the free use of quinine and prophylactic measures, such as the adoption of mosquito-nets and mosquito-proof rooms, and also more sanitary conditions, which tend to reduce the number of mosquitos, this disease does not now account for nearly so many invalidings and deaths as formerly. In spite of the length of time since the connection between Anopheline mosquitos and malaria was established, it is surprising how little is still known of the actual species which are implicated in its transmission in Africa. A fruitful line of research, and one by no means difficult to accomplish, would be the wholesale dissection of the various species of Anophelines found in each and every district, in order to ascertain which species, and what percentage of specimens, contain sporozoits of the malaria parasite.

### Yellow fever.

There is still some difference of opinion as to whether this disease is actually endemic in West Africa, but that it does exist in that region there is now no doubt, and further, it is becoming more and more evident that it has a strong hold. The number of cases among the native population is very small, but among Europeans it is relatively very heavy. Southern Nigeria has not suffered so much as the Gold Coast, Sierra Leone and the Gambia, but two cases occurred in Lagos in July and September, 1910, in which the symptoms were strongly indicative of this disease. The degree of immunity of the natives is still a matter under discussion, and whether the children harbour the parasite, as in the case of malaria, is absolutely unknown. It has been shown, but not in West Africa, that this disease is transmitted by *Stegomyia fasciata*, but there is no evidence to justify our supposing that this is the only transmitting agent. In another section I have discussed briefly the distribution of *Stegomyia* in Southern Nigeria.

With the continual intercourse of natives between the various West African colonies, there is a constant risk of this disease spreading, and it may be that many natives harbour the parasite without themselves showing any symptoms of the disease; if so, the risk to Europeans is very much greater. Since it is known that the disease is transmitted by *Stegomyia fasciata*, and that this species is so common all along the coast, and when the number of European deaths from this cause during the past year is recalled, it is surely not too much to say that every effort should be made to diminish the number of mosquitos. It is gratifying to note that the Government of Southern Nigeria has not been behind in this work, and that recently a quarantine station has been erected in one of the side creeks near Forcados, away from the beaten track.

### Sleeping Sickness.

This disease seems to be far from common in Southern Nigeria. Several doubtful cases in natives have been recorded, but not within recent times has

there been anything like an epidemic. One European, however, contracted this disease in the Cross River region. It might be well to remember, however, that, should any cases be found and it be considered necessary to isolate them, no region could be more favourable for such a camp than in the northern part of the Western Province near Shaki, because from this region no *G. palpalis* has been recorded nor is it likely that it exists there.

### Elephantiasis.

This malady is not infrequent in the Colony, but what insect or insects are implicated in its transmission is entirely unknown.

### Calabar Swelling.

This disease was first described from Southern Nigeria and, though not fatal, causes very great suffering. Several Europeans, especially those in the coast region, have become infected, but by what species of insect is as yet unknown.

### Trypanosomiasis of Stock.

This is everywhere to be found. Except in a very few places, and then only by careful supervision, is it possible to keep horses in Southern Nigeria; sooner or later they succumb. Cattle do not die off so quickly, but it is hardly possible to find an animal not infected with trypanosomes. The mortality from the disease itself is practically nil, as the natives kill and eat all animals as soon as they show very advanced symptoms. Interesting in this connection is the fact that in a very few districts there is a small breed of cattle, mentioned elsewhere in the report, which is said to be immune to this disease.

### Piroplasmosis.

This disease, so far as I could learn, is almost entirely confined to dogs.

### Plague.

Though occurring both sporadically and in endemic form in the Gold Coast, plague has not yet been recorded from Southern Nigeria. It is interesting to note, however, that the writer obtained a plague flea (*Xenopsylla cheopis*) from a rat (*Mus rattus*) captured at Lagos. This fact should not be overlooked, and it is desirable that measures for the wholesale destruction of rats should be encouraged, because, in the event of the disease being once introduced, there is reason to believe that the factors exist for its distribution.

## VI.—The Distribution of Glossina.

Altogether nine species of *Glossina* have been recorded from Southern Nigeria, the largest number found in any one British colony. These belong to all the four groups described by **Austen** in his "Handbook of the Tsetse Flies." The following notes will serve to illustrate the main points in the distribution of the various species, though it must be remembered that the records at present available are far from exhaustive. The accompanying map will show in a more concrete form the general trend of the distribution.

### (*a*) G. palpalis-group.

Belonging to this group there are no fewer than four species found in Southern Nigeria. By far the most widely distributed of these is *G. palpalis*, which may be said to follow all the different river systems. This, however, is not surprising when it is remembered that, no matter how widely separated are the origins of these river systems, they are all linked up along the coast region by a series of lagoons and creeks. In the Western Province this species has been found on the Yewa River, and probably extends to Meko and beyond. It also occurs in the lagoons near Lagos, at Agege, and further north on the Ogun River near Aro. Further east, it has been recorded from the basin of the Oshun River, at Oshogbo, while in the same system it has been found between the Oshun and the Oni Rivers, at Ilesha and elsewhere in this district, and also on the Oni River itself. It may be said to be ubiquitous in the Niger system and especially abundant in the delta—while extreme records in this area are Benin City and Agbor. It is also found in the basin of the Imo, for example at Bende and between Okigwi and Afikpo ; moreover it is everywhere abundant in the Cross River area.

It is interesting to note that in the Niger delta region the specimens belonging to this species, as at present known, are rather darker and larger than the typical forms, while these diminish in size and become much paler in colour north of Aboh and Onitsha.

*Glossina tachinoides* has been recorded from only two places in Southern Nigeria, namely, Ikom and Bende. It is extremely common in Northern Nigeria, and the record from Ikom is not surprising, but its occurrence at Bende would seem to indicate that it may be found more commonly in the Cross River basin than is supposed.

*Glossina caliginea.* This species, only recently described, has been recorded from comparatively few places, but these are so widely separated that it will probably be found to occur along the whole of the coast belt. As will be seen from the map, it occurs on the Yewa River, Oni River, Niger Delta, Kwa-Ibo River and the Cross River. So far, this species has been found only in this Colony. Nothing is known of its habits or life-history beyond the fact that it is a ferocious biter.

*Glossina pallicera* is one of the rarest of the West African species of *Glossina.* A single specimen taken by the writer at Benin City, in March, 1910, is so far the only record from this Colony.

### (*b*) G. morsitans-group.

Of this group only one species, *G. longipalpis*, is known from Southern Nigeria. Although *G. submorsitans* is very common in Northern Nigeria, it is not found so far south as this Colony, but if the Shaki district were examined, it is possible that it would be found there.

*G. longipalpis* is known to occur in Southern Nigeria, in the drier parts of the northern districts of the Western Province, and also in similar situations in the Central Province.

### (c) G. fusca-group.

Three species belonging to this group are represented in Southern Nigeria. The only other species so far attributed to this group is *G. fuscipleuris*, of which only the type specimen, from the Congo Free State, is known.

*Glossina fusca* is most common in the hilly regions of Ilesha and Oban, but has also been found on the Yewa River and at Bende, while a single specimen was taken by the writer at Yaba, near Lagos. This species has been recorded only once from Northern Nigeria, and that from the Kabba Province, which borders on Southern Nigeria.

*Glossina nigrofusca* has been found only on the Oni River, but, as in the case of *G. caliginea*, its distribution probably extends along the lagoon-delta area.

*Glossina tabaniformis* has been recorded from only two localities in Southern Nigeria, namely, Ikom and Oban, both in the Cross River basin and at the foot of the Kameruns.

### (d) G. brevipalpis-group.

The only species belonging to this group which occurs on the West Coast is *G. medicorum ;* it has been recorded only once from Southern Nigeria, namely, from Asaba. The other two species, *G. brevipalpis* and *G. longipennis*, are peculiarly East African forms.

These few notes refer particularly to the distribution of the various species in Southern Nigeria, but I should like here to add some remarks on the general distribution of some of these species in Nigeria as a whole. For this purpose the general physical configuration, the nature of the vegetation, and the character of the climate and rainfall must be taken into account. The main characteristics of each of these have been given in some detail in this and a previous report, so that it is necessary here only to refer to the more prominent features.

Nowhere in this area are there any very prominent mountains, and, as those ranges which exist are important only in so far as they constitute the various watersheds, they may be considered in a very general way. The most important of these is the Bauchi Plateau, which separates the Niger-Benue river system in Northern Nigeria from the Lake Chad system. Next, there is a spur of the Kameruns, which abuts the boundary of Northern and Southern Nigeria and separates the Benue system from that of the Cross River. In the north-west of Southern Nigeria, there is a small range of hills which divides the Niger from the series of small rivers in the Western Province of Southern Nigeria, while this same range, continuing southwards and eastwards, forms the western limit of the Niger system.

Thus it will be seen that there are four separate river systems. By far the largest and most important is the Niger-Benue system, which drains nearly half of Southern Nigeria and almost three quarters of Northern. In Southern Nigeria there is also the Cross River system in the Eastern Province and a series of small rivers in the Western, while in the north-east corner of Northern Nigeria there is the system of rivers which drain into Lake Chad. It has been noted elsewhere in this report that along the coast region of Southern Nigeria all the rivers in that colony are united by a series of creeks and lagoons. Consequently,

their insect faunas must constantly intermingle, and it would be surprising if they were distinct. The Lake Chad system is therefore the only one which can be considered as topographically distinct from the others.

It is extremely difficult to express in general terms the distribution of the various types of vegetation in this area, but in the coast region the mangrove holds exclusive sway, while in Southern Nigeria and the southern parts of Northern Nigeria the fresh-water swamp forest is predominant, especially in the valleys of the rivers. Further removed from the larger streams, there is a certain amount of mixed deciduous forest, while in the north of Northern Nigeria the savannah forest, and ultimately almost pure savannah, is found.

In the south of Southern Nigeria the climate is equatorial, *i.e.*, there is no true separation of dry and wet seasons; in the northern districts, and in the south of Northern Nigeria, there is a transition stage between this form and the true tropical form, in which the dry and wet seasons are perfectly distinct and of almost equal duration. Details of these forms have already been given in these reports.

How far, then, is the distribution of *Glossina* correlated with these phenomena? The species to which I would draw attention here are:—*G. palpalis* and *G. tachinoides* in the *palpalis*-group; *G. submorsitans* and *G. longipalpis* in the *morsitans*-group; and *G. fusca* in the *fusca*-group.

Of these by far the most widely distributed is *G. palpalis*. This species is ubiquitous along the coast region and follows the course of all the rivers. It is especially abundant in the delta area and is found at all parts of the Niger within British territory. In the smaller rivers in the Western Province of Southern Nigeria it is found at considerable distances from the coast, while it is the prevalent species throughout the Cross River, at any rate up to the point where this river enters German territory.

On the Benue River it has not been found further up than Loko, a station not far from Lokoja. Consequently, this species exists wherever the rainfall is great, where the dry season is not of long duration, where the vegetation is dense, and always along the basins of rivers. Where any or all of these factors are less accentuated, the number of individuals tends to decrease, for example, in the higher reaches of the River Niger and on the Benue.

The conditions which are most favourable for *G. palpalis* are, generally speaking, most unfavourable for *G. tachinoides*. Where the country is open, the vegetation sparse, the dry season well defined and the rainfall slight, there *G. tachinoides* is most abundant. Consequently, this species is the predominant one in the region bordering the Sahara in Northern Nigeria; it is the only member of the *palpalis*-group found in the Lake Chad area.

We may therefore consider the dispersion of *G. palpalis* as coming from the south and of *G. tachinoides* from the north, so that in the intermediate region both species occur, and, according as to which of the two sets of conditions already mentioned is most marked, there will be a preponderance in the number of individuals of one or other of the species. A comparison of the map which accompanies this report with that given for Northern Nigeria will show that this is precisely what occurs.

Only two species belonging to the *morsitans*-group occur in this area, namely, *G. submorsitans* and *G. longipalpis*. The former is confined entirely to Northern Nigeria, while the latter, though fairly abundant in Southern Nigeria, is very scarce in Northern Nigeria and is found only in the southern portion. Neither of these species is so intimately associated with the rivers as *G. palpalis*, but they are found in the more open country. Broadly speaking, *G. submorsitans* inhabits the drier regions where the savannah forest is predominant, being, consequently, similar in habits to *G. tachinoides*; while *G. longipalpis* is associated with a moister climate and a slightly denser vegetation of the mixed deciduous forest type.

The distribution of *G. fusca* is almost coterminous with that of *G. longipalpis* and its habitats are similar. It favours dense vegetation and a moderately moist climate.

I hope in a future paper to deal at greater length with the distribution of not only *Glossina*, but also the various species of TABANIDAE and CULICIDAE, but these few notes may serve to show along what lines the factors influencing distribution may be sought.

One thing at least is evident from a study of the distribution of the various species of *Glossina*, namely, that cattle and horse trypanosomiasis in Nigeria is not associated with one and only one species. This disease is prevalent in the Lake Chad area, where only *tachinoides* and *submorsitans* are found, while it is equally prevalent in the western province of Southern Nigeria, where *palpalis* and *longipalpis* are the predominant species.

In my report on the Gambia* I added a few notes on the bionomics of *Glossina*, and as these are equally applicable to Southern Nigeria, there is little necessity for again recording them. Further, throughout the present report I have added whatever seemed important as to prevalence, nature of habitat, &c., of *Glossina palpalis*, but I should like to draw attention to our scanty knowledge of the bionomics and life-histories of the other and rarer species.

## VII.—THE DISTRIBUTION OF STEGOMYIA.

In view of the connection between this genus of mosquitos and yellow fever, it has been considered advisable to recall briefly what is known as to its prevalence in Southern Nigeria. Two papers have recently appeared in this Bulletin bearing upon this question, so that I do not propose to deal with it at any length. The first of these papers was by the late Sir Rubert Boyce,† in which he drew attention to the prevalence of yellow fever in West Africa and afterwards to the high percentage of *Stegomyia fasciata* mosquitos in the coast towns. The second was written by Dr. W. M. Graham,‡ and gave the results obtained from a monthly examination of native domestic water-receptacles at Lagos in 1910–11. The total number of receptacles examined was 1,043 and in 965 of these, *i.e.*, 92·5 per cent., larvae of *Stegomyia fasciata* were obtained. He proceeds to say: "It is the commonest species of larva, is widely distributed over the township

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* Bull. Ent. Res. II, pt. 3, pp. 187–239.
† Bull. Ent. Res. I, pt. 4, pp. 233–263.
‡ Bull. Ent. Res. II, pt. 2, pp. 127–136.

and is found in all varieties of water-vessels. It is hardy and not much affected by environment, living in both clean and foul water with equal facility. Its chief natural enemy in these water-receptacles is the large carnivorous larva of *Culex tigripes* var. *fusca*, Theo."

In all, five species of this genus have been recorded from Southern Nigeria, and it might be well to review the distribution of each of these. By far the commonest, both as regards individuals in any one locality, and also in general distribution, is *S. fasciata*, but it is far from probable that the records here given are by any means exhaustive for the Colony. So far as can be judged at present, this species is most abundant in the Niger delta region. It has been found at Sapele, Warri, Forcados, Burutu, Brass, Akassa, Bonny, Opobo and Degema, and may be said to be ubiquitous in this area. It is almost impossible from a mere examination of specimens sent in by collectors to form any reliable estimate of the relative abundance of the species as compared with the total mosquito population, for collections made at different times of the day give different results and a great deal also depends on the situations in which the mosquitos have been caught.

In the Western Province, *S. fasciata* has been recorded from Lagos, Yaba, Oshogbo and Ilesha, while in the Eastern Province it has been caught at Calabar, Ikot-Ekpene and Bende. It should be noted, however, that at all these places considerable collecting has been done, and this may account for the apparent gaps in the distribution, and it will probably be found, when the fauna of other regions is better known, that it occurs all over the Colony. It has recently been taken at Maidugari, near Lake Chad, in N. Nigeria, and at Geidam, on the edge of the Sahara, where the climate and other conditions are extremely divergent from those in, for example, the Niger delta.

*Stegomyia africana* has been found at Lagos, Yaba, Oshogbo, Forcados and Bende ; *Stegomyia apicoargentea* at Yaba and Bende ; *Stegomyia luteocephala* at Yaba and Bende ; and *Stegomyia sugens* at Oshogbo.

It is probably too sweeping to say that *S. fasciata* is the most common mosquito on the coast, because the records based on large collections of mosquitos made in Southern Nigeria do not altogether bear this out. As has been noted, however, this may in part be due to the method of collecting, and in part to the time and situation chosen for such work.

The danger is, however, none the less minimised by this, and every effort should be made to exterminate the pest. As in the case of other mosquitos, measures should be directed against the larvae. It is now well known that *Stegomyia* is a "small receptacle" breeder and is not commonly found in the vicinity of swamps. All vessels which might retain water ought to be inverted when not in use and stringent efforts should be made to ensure that this is done in native compounds. Further, it ought to be a punishable offence to have within a compound any receptacle containing mosquito larvae of any description. Unfortunately, this offence is not restricted to native quarters, and the servants of Europeans are often offenders in this direction. To supplement this work, European residences should be segregated from native villages. In this connection one might mention that the town of Lagos is the most flagrant example of the intermingling of native and European houses.

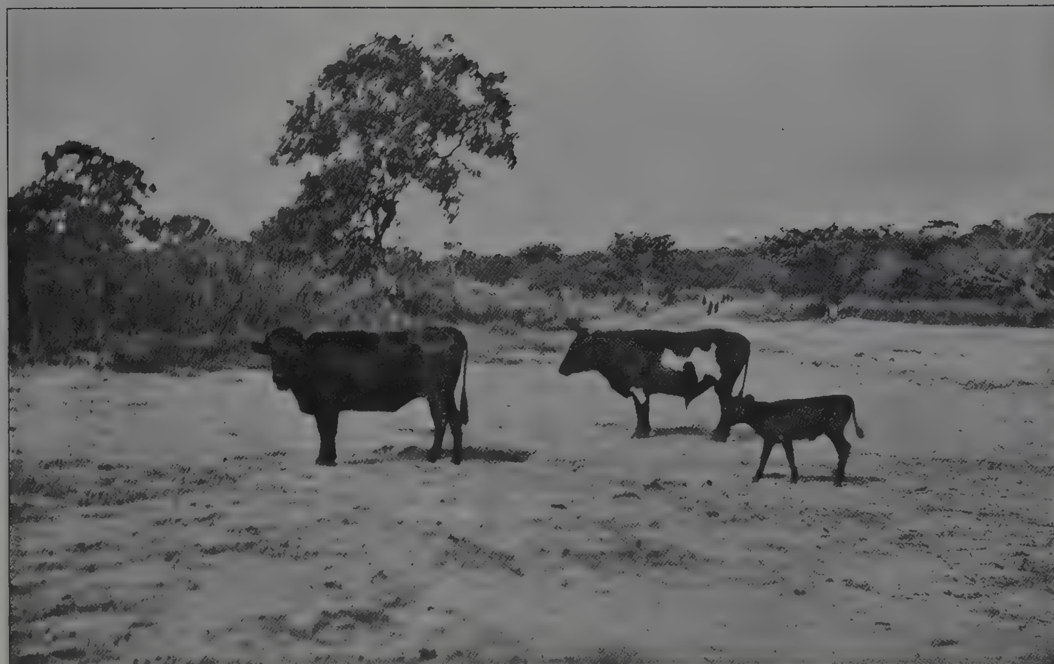
In conclusion, I wish to take this opportunity of recording my indebtedness to all those whose names appear in this report, for their kind assistance in furthering the investigation, and at the same time express the hope that this work, so well begun by them, may be continued and may also stimulate others to similar efforts, so that soon our knowledge of (1) the distribution of blood-sucking insects, (2) their habits and habitats, and (3) the diseases with which they may be implicated, may be such as to form a sound basis for thorough-going prophylactic measures, to the everlasting benefit of not only the native population, but also of the many Europeans who are compelled to spend a great part of their lives in this not over-salubrious Colony. Already much has been done in this direction, and the invaliding rate is being reduced annually, but more strenuous efforts will have to be made, based on a fuller knowledge of the underlying causes and principles. This, in turn, is possible only by continued work along the lines indicated in this and similar reports.

Especially, however, would I express my indebtedness to His Excellency the Governor, Sir Walter Egerton, K.C.M.G., than whom no one is more keenly alive to the necessity for this work, for the many ways in which he assisted me during my stay in the Colony, and for his many personal as well as official kindnesses; to Col. H. C. Moorhouse, D.S.O., whose suggestions, based on an intimate knowledge of the Colony, were invaluable in carrying out the work expeditiously; to Dr. W. H. Strachan, C.M.G., the Principal Medical Officer, from whom I received every facility and assistance; to Dr. F. G. Hopkins (now Principal Medical Officer of the Gold Coast), for his kind co-operation and the many ways by which he sought to place the investigation on a sound basis; to Dr. T. F. G. Mayer, whose paper already published in this Bulletin is a permanent record of genuine interest; to Dr. Connal, for his valuable collections and observations and also his personal kindness during my residence at Yaba; to Dr. A. W. S. Smythe, in remembrance of many profitable excursions by launch in tsetse-haunts; to the various Marine and Railway officials whose ready co-operation and assistance were everywhere manifested; and to these and other political and medical officers in whose districts I travelled and with whom my work brought me in contact for their whole-hearted sympathy, the interest everywhere shown, and much kind hospitality.


MAP OF
SOUTHERN NIGERIA.
To accompany Report by
JAS. J. SIMPSON.
SHOWING THE DISTRIBUTION OF THE GENUS GLOSSINA.
Route followed by the Author
Localities where Glossina palpalis was found
" " " tachinoides " "
" " " caliginea " "
" " " pallicera " "
" " " longipalpis " "
" " " fusca " "
" " " nigrofusca " "
" " " tabaniformis " "
" " " medicorum " "
SCALE OF MILES
10 5 0 10 20 30 40 50 100 150
REFERENCE.
Boundaries, international
" , intercolonial
" , provincial
Railway
Roads, wagon
" , hammock
Paths
Telegraph
" , along road
" Office T.
Customs Station C.
Provincial and district names shewn in red.
Tribal names in green.
Head Quarters of districts shewn thus ⊙ Oban
NORTHERN NIGERIA
DAHOMEY
KAMERUN
BIGHT OF BENIN
GULF OF GUINEA
LAGOS
PORTO NOVO
ILLORIN
OFFA
WARRI
CALABAR
BONNY
BUEA

1913. P11/21.1150.9.12.

Humped Cattle of the breed prevalent throughout Nigeria.



Dwarf Nigerian Cattle of a breed which is apparently immune to trypanosomiasis.

Fig. 1. Mangrove Swamp near Forcados, but typical of any part in the Niger Delta.

Fig. 2. View on the Cross River, to show the extent of the clearing around the trading factories.

Fig. 1. View on the Cross River, to show the nature of the vegetation on the banks.

Fig. 2. View on the Cross River, to illustrate the enormous fall in the level of the river during the dry season.

# NOTES ON THE HAUNTS AND HABITS OF GLOSSINA TACHINOIDES, NEAR GEIDAM, BORNU PROVINCE, NORTHERN NIGERIA,

By Dr. Bernard Moiser, W.A.M.S.

The following notes are presented in the simple form in which they were jotted down at the time, as it seems to me that this will be the best way to give a clear idea of what was observed.

On 3rd Nov. 1911, I received native information as to the presence of tsetse-flies at Bellaram, about 4½ miles S.W. of Geidam, North Bornu. I therefore sent out a man the next day to catch some of the flies and he returned the same evening with four specimens of *Glossina tachinoides.* On 6th Nov. I went to the place to investigate the haunts and habits of the flies.

The country generally is flat and sandy, with clay on the surface in parts, the subsoil being clay and white sand. The River Wobe runs a tortuous course in a broad valley about 1½ miles wide, with marshes on either side, which vary greatly in extent. In the drier portion of the valley there are shady trees in parts, with open spaces covered with long grass at this time of the year, while here and there occur patches of dense jungle, with thick undergrowth and twining creepers. It was in one of these thick patches of jungle that I found the flies to be located. The accompanying map (plane table) shows the position and surroundings of the "belt."

The "Bulama" (headman) of the village of Bellaram, about 1¾ miles distant from the belt, says that the flies have existed in this spot ever since he was born (about 30 years). He says they are confined to the thick bush, and only occasionally leave it. He knows of the case of one man, a constant grower of onions in the "kurimi" (the patch of dense bush), and consequently much bitten by the tsetse-flies, who died after about a year's illness, during the last 8 or 9 months of which the man "did nothing but sleep." He was awakened for food, and then immediately went to sleep again. This history seems strongly suggestive of a case of sleeping sickness.

Also, two men, of about 60 years of age, from the same village, say that the flies have existed in the kurimi during the whole of their lifetimes, and that their fathers had told them that the flies have always been there. They say that the tsetses are more numerous *in the kurimi* in the dry weather, when there is little water in the river, from February to June. They explain this by saying that in the wet weather when the "fadama" (open marshy land) is covered with long rank grass the flies come out of the kurimi and enter the grass, where a few can sometimes be found. When dry, the grass is always burnt, and so, for want of cover, the flies retire to the kurimi.

On the map will be seen the village of Dama, on the opposite side of the valley, but only about 400 yards from the nearest point of the kurimi, and separated from it by open marsh and river. I interrogated the people of this village, and they told me that they know that the flies live in the kurimi, but that they never cross the river into their village. These people keep numbers of cattle there, so that it appears that the flies are very loth to cross the open ground.

The birds seen were guinea-fowl, francolin, pigeons and doves, hornbills, night jars (?), finches, &c.

7th Nov.—I remained in the kurimi all day with eleven men. The flies bit us freely, except for a couple of hours in the middle of the day, when they were noticeably scarce. They were at all times very difficult to catch. We did not observe one on the ground, nor resting on tree-trunks or leaves. While sitting for several hours in one place, it was noticed that sometimes half-a-dozen flies suddenly appeared, remained to feed on us for say five minutes, then took to flight, and then for a space of ten minutes or so no flies would be seen, when again more would suddenly come on the scene. I had six men posted up trees, at heights varying from 10 to 25 feet, for an hour, and not one of them reported having seen a fly, although we on the ground saw several during that time. So it appears that the flies always keep fairly close to the ground.

The method of feeding was observed to be as follows :—

The fly alighted on the skin of a human being and remained quite still for 5 to 20 seconds with its proboscis enclosed in the palpi and held in a line with its body. Then the fly adjusted the position of its legs, so as to raise its body, the proboscis was suddenly brought down at right angles to the line of the body, perpendicular to the skin of the man, and at the same time the palpi were raised a little higher. The proboscis was then driven into the skin, steadily and continuously, almost up to the bulb. After remaining thus for 3 or 4 seconds, the proboscis was retracted without withdrawing the tip, and again driven in. Each act of insertion and retraction occupied about 8 to 12 seconds, the rate of insertion being much slower than that of retraction. These movements were repeated 5 or 6 times, as a rule, and at the end of that time the fly was distended with blood and took to flight.

The bite was generally attended by a pricking sensation, but sometimes there was no feeling whatever. Only one bite caused me considerable itching, which lasted into the next day. The flies settled most frequently on the bare backs of the men, who were sitting on the ground. They also bit me freely through the back of my dark brown "bush-shirt," as well as on my bare forearms and hands. I saw a few on the shaven heads of the men.

9th Nov.—Examined closely the edges of the marsh, but saw very few tsetse, and those seen were nearly always under the shade of large trees, very rarely in the open sunlight. In several specimens, both male and female, caught to-day, distended with blood, I noticed a large bubble of gas in the abdomen. The bubble remained uppermost when the fly was slowly rotated round a horizontal axis, and also ascended as far as the last segment but one, when the fly was held head downwards.

Spent some time trying to see tsetse-flies at rest on the ground, but did not see one in that position.

10th Nov.—Twenty-five flies were placed in one bottle (A), and four in another (B), and closely watched. The insects were very restless, rarely remaining stationary for more than a few seconds, and constantly rubbing together their fore and hind legs. When the flies are at rest, the distal third of the proboscis is often gently bent up and down, appearing above and below the palpi. They constantly stroke the head, abdomen, and wings with their legs, exactly

after the manner of house-flies. When completely at rest, the halteres are motionless, but when the hind legs are moved or rubbed together, the halteres are moved up and down, slowly enough to be easily followed by the eye.

On one occasion a fly was seen to feed upon the abdomen of another. The biter was a female, the bitten fly a male, which had been on its back for some time, unable to rise, and so appeared in a weakly condition, but was not dead. The female inserted the proboscis into the abdomen on the ventral aspect, and worked it backwards and forwards, never quite withdrawing it, but again pushing it in in another direction. While this was in progress, a second fly appeared, and attempted to obtain a feed from the same male, but was apparently driven off by the female spreading out her wings and legs.

In the evening the flies were very hungry, constantly feeling the sides and bottom of the bottle with the unsheathed proboscis. A bit of fairly dry branch of a tamarind tree, and two leaves of the ebony tree were put into the bottle (A). The flies rarely alighted on the leaves, and only a few settled on the twig. One was seen trying to insert its proboscis between the bark and wood of the twig, the head of the fly being in a tremulous condition, suggesting supreme effort.

While watching a female at rest on the floor of the bottle, I noticed a violent contraction of the abdomen, starting from the thorax, and immediately a white larva was extruded. The fly remained on the spot for a few minutes, and then flew away. The larva was quite white, the "tumid lips" being absolutely transparent, resembling bubbles of water, and in a very short time regular rhythmic contractions commenced, starting at the posterior end. The larva was fixed to the floor, and could not be displaced by shaking the bottle. At the end of about ten minutes, the larva was dry, but was still fixed by the tumid lips, the anterior end moving from side to side slightly. Shortly afterwards, it could be displaced by shaking the bottle, and passed into a condition of perfect quietude, exhibiting no movement whatever.

About 4.30 p.m., the fresh liver of a fowl, attached to a piece of string, was lowered into bottle (A). For half an hour the flies took no notice of it, although they seemed to be frantic in their efforts to obtain a feed on the floor of the bottle. Then one fly, and others afterwards, settled on the liver, waited for a minute or so, and then inserted the proboscis into the liver, driving it steadily in as far as the bulb, partially withdrawing it, and again driving it in, repeating the process as many as 50 times, but the abdomen did not become distended to the same extent as it does when the fly feeds on a human being. A large amount of effort seemed to be necessary in retracting the proboscis, the forelegs being pushed hard against the surface of the liver.

At 5 p.m., six flies were dead, and I saw several flies feeding on these dead ones, the ventral surface of the abdomen being chosen as the site for the insertion of the proboscis, the dead fly lying on its back.

Later in the evening, I saw a larva deposited on the twig in the bottle. The larva was born tail-first, *i.e.*, the tumid lips preceding the head and being deposited on to the twig, the rest of the body remaining at right angles to it; but later the larva assumed a more vertical position. This larva never showed any movement, and I am inclined to think that it was killed by the last segment coming into such close contact with the twig. About an hour later, I noticed that four larvae had been deposited on the floor of the bottle.

To-day, my boy informed me that he had seen one tsetse in the camp, about a mile from the belt. This fly must certainly have been a "follower."

The four flies put into the bottle (B) at 11 a.m., were given no food or water. One was a male, and was not distended with blood. This fly was dead at 5 p.m. The other three—females, distended with blood—were still alive and strong.

11th Nov.—This morning, the three flies in bottle (B) are still alive, though evidently weak and hungry. They were all dead at 3 p.m., *i.e.*, after about 29 to 30 hours of starvation.

In bottle (A) one more larva had been deposited during the night, on the piece of liver. It was taken out and placed in another bottle, containing an inch or so of earth at the bottom, to await development.

Nine adult flies are dead, the rest active, and feeding on their dead companions continually. I saw one fly trying to feed on a larva, but the larva was always pushed to one side by the fly in its efforts, so that the proboscis struck the floor of the bottle, and did not pierce the larva. Up to the present, I have kept one fly alive without food for $2\frac{1}{2}$ days in a bottle in which I placed some water, as well as dried leaves and earth.

The idea occurred to me yesterday to set up a large mosquito net, $8 \times 8 \times 8$ feet in the kurimi, thus enclosing a portion of the natural haunt of the flies, in order to find out where they usually rest. Accordingly, at 7 a.m., we proceeded to the kurimi, and set up the net at a chosen spot, so as to enclose the stump of an ebony tree, bearing a few small branches and leaves, and we also put in and arranged branches of other trees of different kinds.

One of my boys and I entered the net at about 10 a.m., taking with us a bottle holding eleven tsetses which had just been caught, and which were then liberated within the net. At first the flies flew in all directions, some five or six of them alighting on the sides of the net, the others being lost to view for a time, but after a few minutes search, we discovered them resting, in an inverted position, on the underside of small branches and twigs close to the ground. They were always on the *under* side of more or less *horizontal* branches, and only occasionally on vertical stems. The branches most favoured were those of about $\frac{1}{4}$ or $\frac{1}{5}$ inch in diameter, and sometimes quite small twigs, but never on leaves of any kind. They usually remained seated for a few minutes only, rarely longer than five, meanwhile constantly rubbing their fore and hind legs together, and then took to flight again. They were not disturbed by shaking the branches, even if this were done quite roughly. One fly was seen to alight on the ground, after having been disturbed from a branch, taking up a position under some dead twigs and leaves. Later, a few more flies were seen on dead twigs on the ground.

We also took into the net a dead monkey, a guinea-fowl and a small blue bird, all of which had just been shot, and these were placed in various positions on the branches; but we never saw a single fly biting them, or even sitting on them, though the flies bit the boy and myself several times. About an hour later, eleven more flies were liberated within the net. One was seen to sit for a few minutes within a hole in the tree-stump. We never saw a fly on the under side of *leaves*, though these were carefully watched; nor was any fly seen to settle on the bole of the tree, except the one that went into the hole, and this did not remain there long.

We did not see a female deposit a larva within the net, though we noticed half a dozen pregnant females on the ground. The flies did not attempt to feed on the juices of the branches and twigs. No particular kind of branch was specially selected as a resting place, though, as a matter of fact, I never saw a fly on the branch of a tamarind tree. No flies alighted on any branch which was more than 5 feet from the ground, and very few settled above 4 feet. Branches between 6 inches and 2 feet from the ground were those most frequently occupied by the tsetses, and I soon found I had to lie on the ground in order to observe them closely. When flying about the interior of the net, the flies generally were about 2 to 4 feet above the ground, rarely higher. I saw only one fly alight on the roof of the net (about 7 feet above ground), but they several times rested on the sides of the net.

The insects did not seem to be nearly so timid and easily put to flight when on branches, as when about to bite a human being, and it was remarkable how violently the branches had to be shaken sometimes, in order to make the flies take to the wing.

These observations were carried on till about 5 p.m.

13th Nov.—Set up the net in a sunny spot close to the kurimi at 9 a.m. A boy and I entered the net, taking with us a living monkey, and we liberated about 30 flies within the net. A dozen of these had been kept without food yesterday, and only about 6 of them were strong enough to fly, the others walked on the ground. The monkey at once saw, and ate or pulled to pieces those on the ground. Up till 4 p.m., the monkey had been bitten four times, but on each of these occasions it felt the prick of the proboscis, and making a grab at the spot, drove away the fly before the latter had had time to obtain a meal of blood. One bite was on the forehead, the other three on the abdomen and sides. One other fly alighted on the monkey, who immediately saw it and drove it away. Several times the monkey drove away flies which were evidently about to alight on his coat.

About 2 p.m., I left the boy to continue observations in the net, while I went into the kurimi with eight men, and we had no difficulty in observing several flies at rest on the under side of small branches, generally within a foot of the ground, and most frequently about 6 inches. The highest one seen was $4\frac{1}{2}$ feet above the ground. We had to crawl and lie on the ground, in order to see the flies, which always took up positions as indicated. A few we saw on the vertical stems of young ebony trees, of not more than $\frac{3}{4}$ inch in diameter. We failed to observe any fly on the ground, but this was possibly due to the extreme difficulty of detecting them in this position. Also, no fly was seen on a leaf of any kind.

Later, the monkey was taken into the kurimi. A native and I remained for an hour, till dark, with the monkey, which was allowed to climb small trees for half an hour, and was afterwards kept sitting quietly on the ground, but we did not see a single tsetse alight on the monkey, although several settled on ourselves.

Later still, at about 7.30 p.m., when it was quite dark, we again entered the kurimi, and attempted to discover the whereabouts of the flies with the aid of an electric lamp. I took ten men with me, but we did not see a tsetse-fly in the space of an hour, nor were we bitten by them, nor did we even hear them on the wing, although we shook the bushes violently. I am inclined to think that we

did not persevere long enough, and had we had a better means of illumination, I think we should have seen the flies asleep on the under side of twigs, or possibly on the ground. I cannot think that the flies had left the kurimi, as the men suggested, or had ascended to the tree-tops, for we had left them in their usual position at dusk.

The following conclusions may be drawn from the fore-going observations and experiments.

(1) Deep shade and proximity to water appear to be the chief factors determining the localisation of the flies.

(2) The natural resting place of *G. tachinoides* is on the lower side of twigs and branches of undergrowth, under the shade of large trees, at a height usually not greater than a foot from the ground.

(3) They are very restless, and do not usually remain long in one position.

(4) The flies do not usually travel higher than 4 or 5 feet from the ground, and probably never ascend as high as 10 feet.

(5) They probably do not feed on monkeys or birds, but on ground animals, *e.g.*, warthog, duiker or bushbuck.

(6) The flies require a meal fairly frequently, and cannot withstand starvation (without water) for longer than 24 to 30 hours. In captivity, at any rate, they will feed on the dead bodies of other tsetse-flies. I am inclined to think, that they may feed naturally on other insects, ticks, grass-hoppers, etc. They certainly feed voraciously on human beings.

(7) I am of opinion, that, during the day, the flies are constantly moving about from place to place within the fly-belt, *i.e.*, in deep shade, and only for short periods rest on the under side of twigs and small branches, and perhaps on the ground.

22nd Dec., 1911.—Left Geidam by barge, and proceeded down the River Wobe. Found a belt of *G. tachinoides*, about 4 miles from Geidam, on the north bank. The flies first appeared in the barge, and, on going to the bank, I found a few to be harbouring in the bushes and long grass on the river bank. There was a belt of thick bush about 150 yards back from the river, and I found numerous tsetses in this bush.

24th Dec., 1911.—Investigated the river bush towards Bultua, about 16 miles eastwards from Geidam. I found two separate localised patches of *G. tachinoides*, neither of them being on the river bank, but bordering on marshes some little distance from the stream.

29th Dec., 1911.—Examined the river bush, west of Jigaje, about 12 miles east of Geidam. I found a belt of *G. tachinoides* on the river bank, probably one of those previously marked by Dr. Pirie; but the natives of the town told me that tsetse have only inhabited this place for the last two years, and were never there previous to this. Again the belt was very localised, being restricted to the thick jungle, formed of shady tamarind trees, ebony trees, and thorns, with a fair amount of undergrowth. The flies were fairly numerous in this belt, but less so than in the others.

Ten living specimens were put into a dry bottle, containing a little of the soil of the locality, and ten others into another similar bottle, except that some water was added. All the flies in the dry bottle were dead at the end of 26 hours,

whereas most of the flies in the wet bottle lived for three days, and the last fly lived till the morning of the 3rd Jan., *i.e.*, four complete days, without any food whatever.

In connection with this, it is interesting to note that I was told by a native of Jigaje that tsetse-flies are in the habit of settling on the mud, when the river is low, and inserting the proboscis to obtain water. I saw this occur several times in the wet bottle, but did not observe anything of the kind on the river bank, which I watched carefully for some hours ; there was, however, plenty of water in the river close by.

6th Jan., 1912.—River Wobe, near Abari, about 6 miles E. of Geidam. I crossed to the north bank of the river in the early morning, and spent the day in examining the bush for tsetse. I found four separate and distinct localities occupied by the flies, all being *G. tachinoides*. None of these belts were close to the river, but bordering on marshes about one-half to one mile north of the river. In each case the flies were congregated in patches of thick shady bush, with a considerable amount of undergrowth, and they were peculiarly confined to these small areas, the intervening open bush being free from them. The chief trees were tamarinds, ebony trees and thorns. The animals seen were warthog, monkeys, gazelle, bushbuck and reedbuck.

In every instance there was standing water in close proximity. I noted a few flies resting on the under side of small twigs and branches close to the ground. I did not observe coitus to take place, but some of the females caught were certainly pregnant. The soil was dark fissured clay, covered, in the dense patches of bush, with humus and débris of twigs and leaves. As usual, the flies did not follow us far into the bright sunlight.

## A clearing experiment with Glossina tachinoides.

The following is an account of an experiment carried out in the fly-belt near Bellaram, referred to above (*see* Map), the object of the experiment being to see if the cutting down of all undergrowth in the kurimi would get rid of the flies.

The clearing of the undergrowth in the kurimi was commenced on 3rd Feb., 1912, starting from the west end, and working gradually eastwards. When about 200 yards had been cleared, and the undergrowth piled into heaps, it was left to become thoroughly dry till Feb. 19th, on which date the dried heaps were burnt, and the ground thoroughly swept, all dried leaves and twigs being thus removed. Meanwhile, on Feb. 15th and 16th, about 500 men were employed in cutting down the rest of the undergrowth throughout the kurimi, and these freshly-cut heaps were then allowed to become dry.

Observations made on Feb. 17th, 19th and 20th, showed that the mere cutting down of the undergrowth had made no material difference to the distribution of the flies. They were still found in the same localities as before, and they did not seem to have spread outside the kurimi.

Of 49 *G. tachinoides* examined, 29 were males and 20 females ; of the latter five were found to be pregnant. The larva was squeezed out of the abdomen in each case, and it was found that in two the tumid lips were already black, these being white in the other three cases. I failed to find any pupae in the soil or amongst the débris of leaves ; nor did I see any flies go to the river to drink water.

Twelve flies were dissected, and examined microscopically for the presence of flagellates, but none were found.

On 17th Feb. two sheep were tied up in the kurimi for an hour, but no flies were seen to alight on them, though we were bitten several times. I saw some herds of cattle, sheep and goats grazing in close proximity to the kurimi, but failed to see a single tsetse on any of them. Several horses were tethered in the kurimi, and these were seen to be bitten by tsetses several times. I hope to be able to keep these horses under observation.

On 19th March I visited the place again, *i.e.*, about a month after all undergrowth had been cut down, during which time the heaps had been allowed to lie on the ground to become dry.

From 10 a.m. till 3 p.m. I took observations in the belt. The cut undergrowth was still on the ground in large heaps, and now thoroughly dry. The remarkably small number of flies seen was in great contrast to the large numbers previously observed. In fact, only four specimens were caught by 14 men during that time, all four being males. It was very evident that the flies had left the kurimi, or were dead. Later in the day, several of the heaps of undergrowth were burnt.

20th March.—From 9 a.m. till noon, I made observations in the kurimi, and during that time I personally saw only two tsetse-flies. Twelve men were stationed in various parts of the kurimi, and they reported that they had only seen two flies, *i.e.*, only four flies were seen altogether. Later, most of the remaining heaps of undergrowth were burnt. I spent many hours searching for pupa-cases, both in the loose earth, and amongst the débris in holes of trees, but without success.

On 21st March, a search was made in the thick bush to the E. and S.E. of the kurimi, to ascertain where the flies had gone. Up to 2 p.m., twelve flies had been caught, six males and six females, of which two were pregnant. One of these extruded the larva after capture, the tumid lips being white.

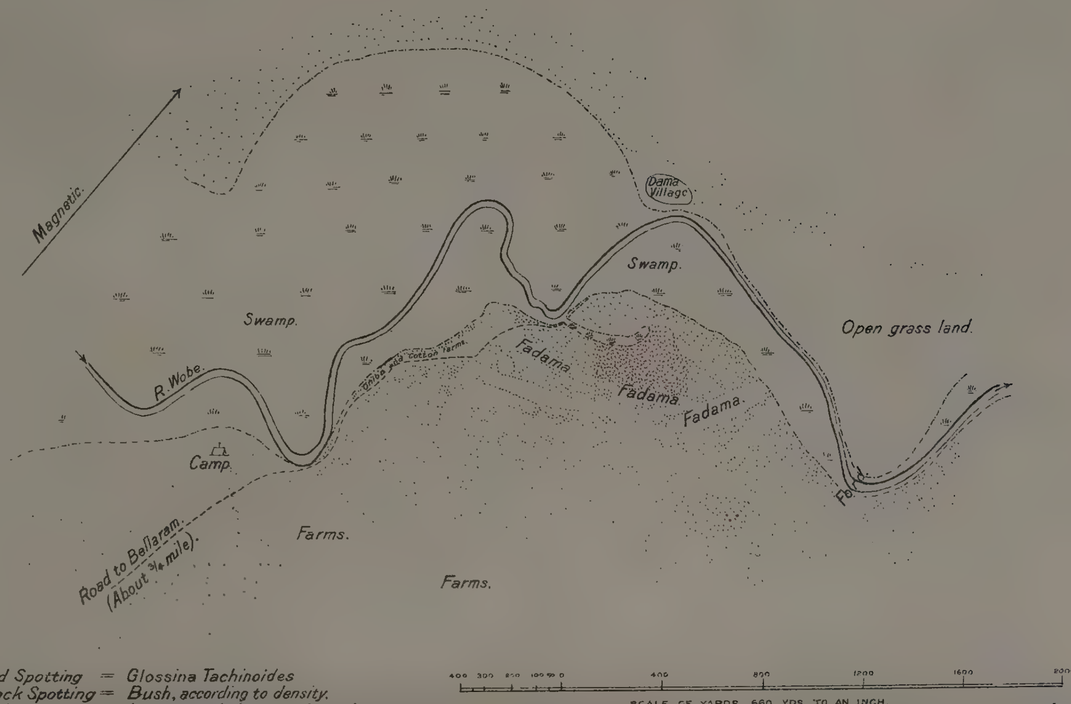
Five of these flies were caught under a dense mass of shady trees and creepers surrounding a small pond. Unfortunately this particular spot had not been previously examined, so that it is impossible to say if the flies had existed there formerly or not. The other seven flies were caught at the spot marked by three red dots on the map, where we had seen tsetses formerly, so that I do not think these flies had come from the kurimi.

In the afternoon a couple of hours were spent in the kurimi, but only one fly was seen during that time. It is thus clear that the flies are no longer living in their former abode. The destruction of the undergrowth has resulted either in the desertion or death of these insects, and it would appear, as far as can be judged at present, that the flies have died, since they cannot be found anywhere in the neighbourhood. This seems to show that the presence of undergrowth (as well as shady trees) is a necessary condition in the habitation of *G. tachinoides*.

The next day, a few odd heaps of undergrowth, which had escaped destruction, were set on fire, so that now the kurimi is absolutely clear of undergrowth, but the tall shady tamarind and ebony trees are still standing. Dried leaves, etc., were also swept into heaps and burnt. During the whole of the day not a single tsetse-fly was seen in the kurimi.

GEIDAM, 23rd March, 1912.

Map showing peculiar localisation of GLOSSINA TACHINOIDES on the R. Wobe, near Geidam, Bornu, N. Nigeria.




Red Spotting = Glossina Tachinoides
Black Spotting = Bush, according to density.
Fadama = Low ground, that may be under water at high flood.

1629. P11/21. 1025. 7.12.

Bernard Thomson - M.O.
Nov 1911.

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# NOTES ON TINEINA BRED FROM COTTON-BOLLS.

By John Hartley Durrant, F.E.S.

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Enquiries are frequently made through the Entomological Research Committee with reference to Tineina bred from cotton, and as the notes on *Gelechia gossypiella*, Sndrs., published by Lord Walsingham in Fauna Hawaiiensis [**1**. 731–4 (1907)] are not generally accessible, I have been requested to revise these notes and reprint them with additional information on *gossypiella* and two species of *Pyroderces*. It is quite clear that the *Gelechia* does immense damage to the cotton, attacking the seeds in the boll, but what damage (if any) is actually occasioned by *Pyroderces simplex*, Wlsm. (= *gossypiella*, Wlsm.), and *rileyi*, Wlsm., is not manifest; it would seem that these species are associated with cotton already injured by damp or other insects rather than themselves being the cause of injury. Further information will doubtless be supplied now that the names are available.

## GELECHIADAE.

### Gelechia, Hb.

### **Gelechia gossypiella,** Sndrs.

(= "The Pink Boll-worm," Mx-Lfry.)

*Depressaria gossypiella*, Sndrs., Tr. Ent. Soc. Lond. **3**, p. 284–5 (1844)[1]: Zool. **9**, p. 3070 (1851)[2]; Swinh-Cotes, Cat. Moths Ind., p. 716, sp. 4900 (1889)[3]; Cotes, Ind. Mus. Notes, **2**, p. 163 No. 148 (1893)[4]

*Gelechia gossypiella*, Meyr., Jr. Bomb. N.H. Soc. **16**, p. 592 (1905)[5]; Mx-Lfry., Agr. Jr. Ind. **1**, p. 49–61, pl. **9** (1906)[6]: Ind. Ins. Pests, p. 93–6, tf. 104–7 (1906)[7]; Wlsm., Fn. Haw. **1**, p. 731–3 and 744, sp. 21·1 (1907)[8]; Mx-Lfry., Ind. Ins. Life, p. 534 and 532 tf. 344 (1909)[9]; Morstatt, Die Pflanzer (Zts. Land-Forst. Deutsch. Ost-Afr.) **7**, 66 (1911)[10].

"Dark fuscous brown, the head and thorax somewhat lighter in colour. Anterior wings with an undefined round blackish spot on the disc a little above the centre, and a fascia of the same colour crossing the wings a little above the apex, which itself is black. Under wings of a silvery grey, darker towards the hinder margin. Legs and tarsi black-brown, with the joints light. Length 4-10ths inch.

"The larva in the dried state is about 4-10ths of an inch long, largest just behind the head, of a dull red colour, with the head dark brown.

"The following is an extract of the letter which accompanied the specimens:— 'The inclosed is an insect which was very destructive to the American cotton which was sown here (Broach), on light alluvial soil. The egg is deposited in the germen at the time of flowering, and the larva feeds upon the cotton seed until the pod is about to burst, a little previous to which time it has opened a round hole in the side of the pod for air, and at which to make an exit at its

own convenience, dropping on the ground, which it penetrates about an inch, and winds a thin web in which it remains during the aurelia state. Curious enough, the cotton on the black soil was not touched by it. The native cotton is sometimes affected by it.'

"In the foregoing extract from Dr. Barn's letter it is interesting to remark, that the cotton grown from American seed is attacked in preference to any other, and that the cotton plant when grown upon 'black soil' remains free from injury. The former fact may be accounted for by the American cotton being of a different species to that usually grown in India, and probably offers seeds which are more suitable to the development of the larva." (*Saunders.*)[1]

Fig. 1.—*Gelechia gossypiella*, Sndrs. ♂ (6011 Lahore, India). × 5.5.

*Larva:* in bolls *Gossypium spp.* [1-9], feeding on the seeds [7,9], I–XII[7].

*Hab.* AFRICA—EGYPT: Damanhour District, larva in cotton-bolls XII, ex. 1.V.1912 (*F. C. Willcocks*)—EAST AFRICA[9]—GERMAN EAST AFRICA[10]: Wilhelmstal[10]—ZANZIBAR: *Dr. W. M. Aders*, no. 4, 1911. ASIA—INDIA[1-9]: BOMBAY[1-9]: Baruch (=Broach)[1-4,8-9]; Surat[5-6,8]; S. Gujarat[7]: PUNJAB[8]: Lahore, "Cotton-boll moth, reared from caterpillars from Lahore" [*E. C. Cotes*; 6010–11 Mus. Wlsm. (1176–7 Drnt. Det. 1894)][8]: OUDH[3,8]: Cawnpore[3,8], Cotton, VI.1883[8]: BENGAL[7]: Behar[7]—CEYLON[7,9]—BURMA[7,9]—STRAITS SETTLEMENTS[7,9]—PHILIPPINES: LUZON: Manila, I.1903 (*W. Schultze*)—JAPAN[8]: (*H. J. S. Pryer* 70795 Mus. Wlsm). HAWAIIA[8]—OAHU[8]: Honolulu, "Tineid of cotton (introduced)," "Highly injurious to cotton" (*R. C. L. Perkins*, no. 4: 1901)[8].

The species varies in the amount of dark suffusion on the forewings, in some specimens the costal area being almost destitute of dark shading. *Exp. al.* 18–21 mm. In the hindwings veins 3 and 4 are connate or stalked in both Indian and Hawaiian specimens.

"The young caterpillar is white, with a dark head, and is found feeding on the leaves or on the outside of the boll. It does not immediately attack the boll but bores in through the rind when it has fed for a few days outside. It feeds upon the oily seeds, eating seed after seed until it has become full grown. As a rule one will be found in a boll but exceptionally several attack the same boll. The full grown larva is of a white colour, with bright pink spots. The larval life varies in duration according to the season but occupies two or three weeks in the active period. The full grown larva forms a slight cocoon of silk, in the boll or on the bracts or leaves of the cotton. The shortest period for the pupa is from fourteen to eighteen days, after which the moth emerges." (*Maxwell-Lefroy.*)[7]

Although originally described from Indian specimens it is by no means certain that *gossypiella* is truly an Indian species, for Dr. Barn's notes, as published by Saunders,[1] indicate strongly that the insect was imported with American cotton, which it preferred to the Indian species of *Gossypium*. Swinhoe and Cotes[3] record *gossypiella* from Cawnpore with a "?"—this mark of doubt is misplaced, the specimen was correctly determined as *gossypiella*, Sndrs., the "?" had reference to its being wrongly described as a *Depressaria* by Saunders. (Durrant and Meyrick have both referred *gossypiella* to *Gelechia*, Hb.)

No special information accompanied this Cawnpore specimen (labelled "Cotton, VI. 1883"), but in the accumulation of "Notes on insect pests from the Entomological Section, Indian Museum," published by the late Lionel de Nicéville in Indian Museum Notes, Vol. V., No. 3 (1903), we find (p. 183) under *Earias fabia* that Egyptian cotton was grown on the experimental farm at Cawnpore. It is therefore presumable that this specimen of *gossypiella* was associated with imported Egyptian cotton. We also read (*l.c.*, p. 183) that: "On 4th December, 1893, the Director of Land Records and Agriculture, Punjab, Lahore, sent some pods [bolls] of Egyptian cotton, containing green and white insects tunnelling into the pods. A single moth was bred from these, but was unidentified." This bred specimen was regarded as probably a variety of *Earias fabia*, but it has been overlooked that *Gelechia gossypiella* was also bred from these Lahore cotton bolls. Two specimens were sent to Merton (6010–11 Mus. Wlsm.) with the note "Cotton-boll moth reared from caterpillars from Lahore" (Cotes, i.l., 19.II.1894)—these were determined as *Gelechia gossypiella*, Sndrs. (1176–7 Drnt. det. 1894). It would therefore seem that both the Lahore and Cawnpore specimens were imported with Egyptian cotton. We have no information as to the probable origin of the Surat specimens recorded by Meyrick[5] and may therefore assume that their history is similar to that of the other Indian specimens. Mr. Perkins notes the Hawaiian specimens as "Tineid of cotton (introduced)"—unfortunately he gives no indication of the locality whence it came—and at present we have no evidence that the species occurs in America, but a single specimen from Japan (70795, Mus. Wlsm.) in a very poor condition would seem to be *gossypiella*.[8]

The suggestion that *Gelechia gossypiella*, Sndrs., was imported into India with Egyptian cotton, and thence distributed eastward receives some support since it has been bred in Egypt by Mr. F. C. Willcocks from larvae collected in the Damanhour District, and in Zanzibar by Dr. W. M. Aders. Specimens from

these and other localities, with exact data, are much wanted. The species most nearly allied to *gossypiella* is *Gelechia malvella*, Z. (2593 Stgr-Rbl. Cat. Lep. Pal. **2**, p. 144), which occurs in Central and Southern Europe, the larva feeding in the seeds of *Althaea* and *Malva*.

## LAVERNIDAE.

### Pyroderces, HS.

### Pyroderces simplex, Wlsm.

**n. syn.**=*gossypiella*, Wlsm.

*Pyroderces simplex*, Wlsm., Tr. Ent. Soc. Lond. **1891**, p. 119–20, pl. **6**, f. 58 (1891).[1]

*Stagmatophora gossypiella*, Wlsm., Ann-Mag. NH. (**7 s.**) **18**, p. 178–9 (1906).[2]

*Pyroderces gossypiella*, Morstatt, Die Pflanzer (Zts. Land-Forst. Deutsch, Ost-Afr.) **8**, 253 (1912).[3]

*Types* ♂ ♀, *simplex*, Wlsm. (♂ 950 ; ♀ 1049); *gossypiella*, Wlsm. (♂ 400,016) Mus. Wlsm. **BM.**

"*Antennae* whitish fawn-colour, spotted with brownish fuscous above. *Palpi* divergent, recurved, slender ; pale fawn-colour, apical joint slightly longer than the second, touched with fuscous above the middle and before its apex. *Haustellum* long, clothed with shining white scales throughout. *Head* fawn-colour ; face slightly paler. *Thorax* fawn-colour, paler posteriorly ; with a

Fig. 2.—*Pyroderces simplex*, Wlsm. ♀ (400,026 Ghezireh, Egypt). × 12.

shining metallic iridescence on the under side. *Forewings* fawn-colour, with a slender outwardly curved transverse whitish streak at one-fourth from the base, preceded by some fuscous scales, which tend to form a basal patch ; some shining whitish scales with a lilac iridescence are continued from its lower end, along the dorsal margin to the base, and extend also outwardly along the dorsal

margin; on the dorsal margin at about half the wing-length is a small, outwardly oblique, spot of fuscous scales; at the extreme apex is a dark fuscous spot preceded by a few scattered paler fuscous scales, which are also to be found along the base of the cilia; cilia fawn-colour, inclining to greyish fawn about the anal angle. *Exp. al.* 9–11 mm. *Hindwings* grey, with fawn-grey cilia. *Abdomen* cinereous. *Legs* pale fawn, inconspicuously banded with darker fawn." (*Wlsm.*)[1]

*Hab.* AFRICA, W-N-E.—EGYPT[2]: Government Gardens, Delta Barrage, larva in cotton-pods (*W. Draper*)[2]; Ghezireh, larva in old cotton-bolls, previously injured by *Earias insulana*, Bdv., etc., ex. 31. III. 1910 (*F. C. Willcocks*, No. 41); Ghizeh, larva on maize-cob, ex. 22. X. 1910 (*F. C. Willcocks*, No. 50)—GAMBIA[1]: Bathurst, XI. 1885 (*G. T. Carter*)[1]; larva bred from a mine in a species of Mallow, XI. 1885 (*G. T. Carter*)[1]—GERMAN EAST AFRICA[3]: Amani, larva in seeds of "Togo-Sea-Island" cotton.[3]

*Pyroderces simplex* was described and figured from the captured ♂ (950); the ♀ (1049), which was bred with various other species from "mallow" by Sir Gilbert Carter, was somewhat injured, and the note "bred from a mine" was applied jointly to the *Pyroderces* and to *Acrocercops bifasciata*, Wlsm., doubtless pertaining more particularly to the latter. The material from which *Stagmatophora gossypiella* was described was in *very* bad condition, but the reception of fine bred specimens, for which we are indebted to Mr. Willcocks, confirms the suspicion that *gossypiella* was founded on worn specimens of *simplex*.

## Pyroderces rileyi, Wlsm.

*Batrachedra rileyi*, Wlsm., Tr. Am. Ent. Soc. **10**, p. 198–9, (1882).[1]
*Batrachetra rileyi*, Dyar, Bull., U.S. Nat. Mus. **52**, p. 534, sp. 6059 (1902).[2]
*Batrachedra rileyi*, Wlsm., Ann. Mag. NH. (**7** s.) **18**, p. 179 (1906)[3]; Swezey, Rp. Exp. Stn. Hawaii. Div. Ent. Bull. **6**, p. 22–4, pl. **3**, f. 9–11 (1909).[4]

*Type* ♂ (33510) Mus. Wlsm. **BM.**

"*Antennae* with white and fuscous annulations; the basal joint elongate, chestnut-brown. *Palpi* widely divergent, whitish, with an oblique pale brown

Fig. 3.—*Pyroderces rileyi*, Wlsm. ♀ (33,898 Miami, Florida). × 22.

mark on each side near the end of the second joint, and two or three brownish spots on the sides of the apical joint. *Head* chestnut-brown. *Forewings* chestnut-brown, slightly shaded with fuscous towards the costal margin ; a whitish ochreous streak at the base of the dorsal margin, followed by two or three other smaller ones along the dorsal margin (in some specimens these are obsolete); above the dorsal margin are two oblique whitish ochreous streaks, the first before the middle, the second before the anal angle. A similar streak from the costal margin immediately before the apex is outwardly margined by a streak of black scales, the apex and apical margin being also black ; there is also a faint fuscous streak running downwards through the cilia below the apex. On the cell are two elongate patches of black scales, one immediately before the middle of the wing, the other halfway between this and the base. Fringes grey, with a slight yellowish tinge. *Expanse* 11 millim. *Hindwings* pale greyish. *Hind tibiae* greyish white, outwardly fuscous ; hind tarsi whitish, with a wide fuscous band followed by two fuscous spots on their outer sides.

1229–30.—“ Bred from rotten cotton-bolls.” (*Wlsm.*)[1]

1229–30 = “ *Tinea* from rotten cotton-bolls, Savannah, Ga. A. R. Grote, Iss., March 3, 1879.”—The origin of the specimens was not stated when the species was described.

*Hab.* AMERICA, N-I. **United States**—GEORGIA[1] : Savannah, larva in rotten cotton-bolls, ex. 3. III. 1879 (*A. R. Grote*)—FLORIDA : Miami, larva in fruit of “ Loquat ” (*Eriobotrya japonica*), ex. 10–11. VII. 1910 (*A. Busck*). **West Indies**—JAMAICA : ST. ANDREW : Constant Springs, 1. I. 1905 (*Wlsm.*). HAWAIIA[4] : larva on dead vegetable matter, refuse substances, insect débris, etc., on various plants[4]—OAHU : N.W. Koolau Range, VII. 1901 (*R. C. L. Perkins*) ; Honolulu, 27. I. 1908 (*R. C. L. Perkins*). AUSTRALIA—QUEENSLAND : Dawson River, 21. IV. 1893 (*G. Barnard*).

This species must be removed from the genus *Batrachedra*, Stn., which has HW. 5-6 stalked, and referred to *Pyroderces*, HS. *Pyroderces rileyi*, Wlsm., is closely allied to *simplex*, Wlsm., but is smaller : both species agree in having FW. 7–8 stalked, 5 out of their stalk, 6 out of 7, and 9 closely approximate to or connate with 8 ; HW. 6–7 stalked. *Stagmatophora*, HS. may be employed for species having FW. 5 separate, 6 out of the stalk of 7–8.

# A NEW SPECIES OF PHLEBOTOMUS FROM SOUTH AMERICA.

By Sophia L. M. Summers, M.A., B.Sc.

*London School of Tropical Medicine; Carnegie Student of the University of Aberdeen.*

## **Phlebotomus rostrans**, sp. nov.

Four specimens—one male and three females—mounted in Canada Balsam were sent from Rio Javary, South America. In this condition nothing can be said about their colour, and very little about the nature of their hairy covering, except that all parts of the body are apparently hairy, as usual, and that the hairs that are left on the abdomen are very long and almost recumbent.


Fig. 1.—*Phlebotomus rostrans*, Summers; *a*, wing; *b*, male genitalia, lateral view; *c*, maxillary palp of female.

*Head* of the female, measured from tip of proboscis, half the length of the rest of the body; clypeus more than ordinarily prominent, its length being about equal to that of the rest of the head. *Proboscis* of the usual form, its free portion in the female slightly longer, in the male slightly shorter, than the combined head and clypeus. *Maxillary palps* in the female (in the single male they are

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incomplete) formed of at least six distinct segments, namely a small basis, followed by two co-equal segments that together make up more than two-thirds of the whole palp, and three short co-equal terminal segments, of which the first (true fourth segment) is broadly expanded (ovate) and the tip of the last (true sixth) is truncated ; the palps have some scales among the hairs, and their total length is about one-third greater than that of the proboscis. *Antennae* in both sexes longer than the whole body (free portion of proboscis excepted), formed of the usual sixteen segments of which the first is truncate triangular, the second globose and the third is much longer than any of the others.

*Legs* of the usual form, in the hind pair the tibia (which, as in all the legs, is the longest segment) is as long as the combined head and body.

*Wings.* In the male the greatest length of the wing is three and a half times its greatest breadth ; it is bluntly pointed and the hind border is not very much more strongly arched than the front border. The length of the second marginal cell is contained $2\frac{2}{3}$ times, and that of the third marginal cell $1\frac{5}{6}$ times in the length of the wing. In the female the wings are decidedly broader, but the relations of the veins are about the same. Halteres large and remarkably long.

*Abdomen.* The male genitalia have the usual general form. In the superior claspers the two segments are of nearly equal length, but the basal segment is very much stouter than the distal segment, being of an unusual elongate triangular shape. The slender terminal segment is armed with only four spines, of which one is terminal, one is situated on a prominent ante-terminal tubercle of the dorsal surface, one stands rather beyond the middle of the supero-lateral border, and one arises from a prominence a short distance behind the middle of the ventral border. All four spines are stout and claw-like ; the terminal one is the stoutest and longest, being more than half the length of the segment that bears it. The inferior claspers have the usual boomerang shape and are about twice the length of the first segment of the superior claspers. At the tip there is a tuft of long erect hairs.

This species is distinguished from any with which I have been able to compare it by the great length of the head (proboscis included) which in the female is half that of the rest of the body. The details of the wing venation very closely resemble those of *P. malabaricus*, Annandale.

The drawings were done by Colonel Alcock, to whom my very best thanks are due for his great help.

# INSECTS DIRECTLY OR INDIRECTLY INJURIOUS TO MAN AND ANIMALS IN MOZAMBIQUE, EAST AFRICA.

By C. W. Howard, B.A., F.E.S.

The following is a list of the more important insects collected in the Province of Mozambique (Portuguese East Africa) and which in some stage of their existence may be harmful to men or animals. During the writer's stay in Mozambique it was impossible to make a complete survey of that immense colony, but as much collecting was done as opportunity offered and this list may be considered a fairly representative one.

The main centres of collecting were in the Lourenço Marques and Gazaland districts, which are at the southern extremity of the area belonging to the "Companhia de Moçambique," of which Beira is the chief town; but collections were also made at the northern border of this same district, along the Zambesi River; in the Zambesia district itself, extending northward from the Zambesi along the coast; and from the mouth of the Zambesi to the Shire River. A few insects were sent in from Mozambique, Tete and Inyambane districts. Consequently representatives of the insect fauna were obtained from the humid northern portions of the Province, which resemble Eastern Central Africa as to climate, and also from the drier southern portions in which the conditions resemble closely those existing in the eastern half of British South Africa.

The following gentlemen have kindly assisted me by determining the different groups of insects for me:—Hon. N. Charles Rothschild, the Siphonaptera; Prof. L. G. Neumann, the Pediculidae and Mallophaga; Mr. E. E. Austen, who determined many of the Tabanidae, Muscidae and Culicidae; and Dr. L. O. Howard, Chief of the United States Bureau of Entomology, who secured the determination of the greater part of the Culicidae and other Diptera.

Occasional mention will be made of specimens collected in the Transvaal and other parts of South Africa.

## Order Hemiptera.

### Family **Cimicidae.**

*Cimex lectularius*, L. This insect is found in most parts of the Province in small numbers, indeed they are so rare that it was difficult to secure specimens. It is a veritable pest in the Transvaal and Southern Rhodesia, especially in the towns and villages.

*Cimex rotundatus*, Sign. Three specimens of *Cimex*, two from houses in Lourenço Marques and one from a native hut at Mopea on the Zambesi River, have been considered as probably belonging to this species. They resemble *C. rotundatus* in the character of the prothorax but not otherwise. As this species is found in India, between which country and the East Coast of Africa

there has been considerable intercourse, it seems probable that it may have been introduced and become established in certain parts.*

## Order ANOPLURA.

### Family **Haematopinidae.**

*Haematopinus eurysternus*, Nitzsch. This louse is found on cattle practically everywhere throughout Mozambique. I have specimens from Lourenço Marques, Chai Chai, Bilene, Inyambane, Mambone, Beira and Sena. I also have specimens from cattle at Vrededorp, Orange River Colony.

*Haematopinus suis* (L.) This louse was taken from pigs at Umbelusi. The following variety seems to be the usual form found.

*Haematopinus suis* var. *adventitius*, Neumann. This variety, recently described by Prof. Neumann, seems to be very common on pigs about Lourenço Marques.

*Haematopinus tuberculatus*, Giebel. Specimens of this species were taken in December, 1909, from buffalos, which had been imported from Timor and were in quarantine on Inhaca (Inyack) Island at the mouth of Delagoa Bay.

*Haematopinus vituli* (L.) These lice were taken from cattle at Pretoria, Transvaal.

### Family **Pediculidae.**

*Pediculus capitis*, De Geer. These are a common pest among the natives. I have specimens from natives on the Zambesi River and from a white child at Maputo, near Lourenço Marques, who had probably acquired them from a native nurse-girl. Those from the natives are very dark in colour. A variety of this species was taken from a native at Mopea, on the Zambesi.

*Phthirius pubis*, L. From a European at Lourenço Marques and also from Europeans at Pretoria.

## Order MALLOPHAGA.

### Family **Philopteridae.**

*Degeeriella vittata* (Giebel). This, together with some of the species to follow, were sent in by correspondents with no notes as to locality or host, except that they were taken from birds.

*Degeeriella bicuspis*, Nitzsch. Taken from Swainson's plover, *Stephanibyx inornatus*, Swains.

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* [The contention that *C. rotundatus* has been introduced into Africa from the East has already been commented upon in this Bulletin (vol ii., p. 180). It was there pointed out that of the numerous bed-bugs received by the Entomological Research Committee from Northern Rhodesia, Nyasaland, and Northern and Southern Nigeria every specimen is *C. rotundatus*; indeed, up to the time of writing, not a single example of *C. lectularius* has been received by the Committee from Tropical Africa. In view of the prevalence of *rotundatus* in N.E. Rhodesia, Mr. Howard's statement that *lectularius* is abundant in S. Rhodesia may perhaps need modification. To the African localities already recorded for *rotundatus* the following can now be added :—

NYASALAND : Fort Johnston (*Dr. A. H. Barclay*) ; BRITISH EAST AFRICA : Mombasa (*Dr. W. Radford* and *Dr. F. L. Henderson*), Kalife (*R. P. Thomas*), Nairobi (*Dr. J. A. Haran, C.M.G.*), Nakuru (*Dr. H. Bödeker*) ; UGANDA : Entebbe (*Dr. G. C. Strathairn*), Lake Albert district (*G. H. Pooley*), Mwanga's, Unyoro (*Capt. E. D. W. Grieg*) ; GAMBIA : Alijamadu (*Dr. J. J. Simpson*) ; SIERRA LEONE : Batkanu (*Dr. J. C. Murphy*), Freetown (*Major F. Smith*) ; GOLD COAST : Tarkwa (*Dr. R. Cope*) ; SOUTHERN NIGERIA : Lagos (*Dr. A Connal*).

So far as Tropical Africa is concerned, *C. lectularius* is represented in the British Museum collection by only a single specimen from Freetown, Sierra Leone.—Ed.]

*Degeeriella sp.*

*Goniocotes gigas*, Nitzsch. From fowls, Johannesburg, Transvaal.

*Goniocotes hologaster*, Nitzsch.

*Goniodes stylifer*, Nitzsch. From a domestic turkey, Manhiça.

*Lipeurus columbae* (L.). From domestic pigeons, Lourenço Marques.

*Lipeurus heterographus*, Nitzsch. From fowls, Pretoria, Transvaal.

*Lentes capensis*, L. From fowls in Wolmaranstad District, Transvaal.

*Philopterus semivittatus*, Giebel.

*Philopterus setosus*, Piaget. From *Halcyon chelicuti*, Stanl., at São Paulo.

*Philopterus platystomus*, Nitzsch. From yellow-billed kite, *Milvus aegyptius*, Gmel., in Lomagundi District, Southern Rhodesia; also from an eagle, probably *Aquila rapax*, Temm., near Lourenço Marques.

*Philopterus sp.*

### Family **Liotheidae.**

*Liotheum caudatum* (Giebel). From Secretary Bird, Pretoria.

*Liotheum longicaudum*, Nitzsch.

*Menacanthus spiniger* (End.)

*Menopon biseriatum*, Piaget.

*Menopon trigonocephalus*, Olfers. From fowls in Gazaland and Zululand.

*Menopon sp.* In the ears of Burchell's coucal, *Centropus burchelli*, Swains., at Manhiça.

*Trinoton anseris*, Sulz. From a small wild duck on the Maputa River.

## Order SIPHONAPTERA.

### Family **Pulicidae.**

*Ceratophyllus numae*, Roths. From field-mouse, *Arvicanthis pumilio*, Spar., about Pretoria.

*Ctenocephalus canis*, Curtis. On dogs and in houses at Lourenço Marques, Umbelusi, São Paulo, Mambone, Zambesia District. I have also taken them in houses at Pretoria, and from the following wild animals:—*Erinaceus frontalis*, Smith, at Pietersburg, N. Transvaal, *Felis nigripes*, Burchell, at the Pretoria Zoological Gardens, and from genets (*Genetta felina*, Thb.), at Lourenço Marques.

*Ctenocephalus felis*, Bouché. From dogs at Umbelusi, and also at Pretoria. From cats at Lourenço Marques and Pretoria. Specimens were also found in the sand near a pigeon-cot in the neighbourhood of Lourenço Marques.

*Ischnopsylla incerta*, Roths. From bats at Chibuto.

*Xenopsylla cheopis*, Roths. From rats at Lourenço Marques.

*Xenopsylla scopulifer*, Roths. Probably from rats.

*Pulex irritans*, L. From a house at Tzaneen, Northern Transvaal.

### Family **Sarcopsyllidae.**

*Dermatophilus* (*Sarcopsylla*) *penetrans*, L. Very common in the central and northern parts of the Province, but I have never seen it in the southern districts.

*Echidnophaga gallinacea*, Westw. Taken from fowls at Lourenço Marques and Magude; from dogs at Nkanene and Umbelusi; from domestic rabbits at Magude; and from cats at Quelimane. I have also taken them from fowls and cats at

Pretoria, and from an eagle, probably *A. rapax*, which had been in captivity for three days, near Lourenço Marques.

*Echidnophaga larina*, Roths. From a wild pig, Hartley, Southern Rhodesia.

## Order DIPTERA.

### Family **Culicidae.**

The following is a provisional list furnished by Mr. Knab of the National Museum at Washington, who has most of my CULICIDAE in hand at the present time. A few species were named by Mr. Austen.*

*Myzomyia* (*Pyretophorus*) *costalis*, Lw. The most abundant Anopheline on the coast, found practically everywhere ; breeds even in the brackish lagoons along the shore line. The recognised malaria transmitter.

*Myzorhynchus mauritianus*, Grp. Fairly common in the Province. Visits houses in company with *M. costalis*, but never occurs in such large numbers.

*Culex fatigans*, Wied. Extremely common and numerous everywhere ; breeds in company with *M. costalis* and *S. fasciata*.

*Banksinella* (*Culex*) *luteolateralis*, Theo.

*Culex decens*, Theo. (*Heptaphlebomyia simplex*, Theo.).

*Culex salisburiensis*, Theo. From the Lower Zambesi River ; named by Mr. Austen.

*Culex thalassius*, Theo.

*Culex tipuliformis*, Theo. (*theileri*, Theo.).

*Culex tigripes*, Grp. Determined by Mr. Austen.

*Culex univittatus*, Theo.

*Eretmopodites sp.*

*Mansonioides* (*Mansonia*) *uniformis*, Theo. From Lower Zambesi River.

*Ochlerotatus* (*Grabhamia*) *durbanensis*, Theo.

*Ochlerotatus hirsutus*, Theo. (*Culex transvaalensis*, Theo.).

*Stegomyia* (*Scutomyia*) *sugens*, Wied.

*Stegomyia africana*, Theo. Determined by Mr. Austen.

*Stegomyia fasciata*, F. (*calopus*, Mg.) Common everywhere in the Province, being, with *Culex fatigans*, the most numerous mosquitos ; they breed in pools with *M. costalis*, even in brackish water, as well as in artificial receptacles.

### Family **Chironomidae.**

*Ceratopogon castaneus*, Walk.† This species seems to be confined to the high veld of South Africa. I have taken it at Pretoria and in trains on the Lourenço Marques-Pretoria railway, but only after the train had reached the high veld.

*Ceratopogon sp.* Specimens of this undetermined species were taken in the Lomagundi District, Southern Rhodesia, in November, 1909, at the end of the dry season, before the rains had commenced.

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* [For the sake of uniformity, this list has been altered in accordance with Mr. F. W. Edwards' revision of the African Culicidae, recently published in this Bulletin (II, pt. 3, pp. 241–268, and III, pt. 1, pp. 1–53). The names used by the author are given in brackets.—Ed.]

† [This identification appears to need confirmation, as Mr. E. E. Austen has pointed out that the species was originally described from Sierra Leone, and the only other authentic specimens known to him are from Southern Nigeria. (*See* Bulletin, III, pt. 1, p. 106).—Ed.]

### Family Simuliidae.

*Simulium griseicollis*, Becker. This species is very common in the Western Transvaal and Cape Colony. In 1907, I found it very abundant at Warrenton, Cape Colony.

*Simulium nigritarse*, Coq. Occurs on the high veld of the Transvaal. I have taken them in trains on the Lourenço Marques-Pretoria railway.

This family seems to be found very rarely in the parts of Mozambique which I have visited, probably because of the flat nature of the country with its sluggish rivers and streams.

### Family Tabanidae.

*Chrysops stigmaticalis*, Loew.* Grünberg records this species from "Delagoa Bay." I have never taken it in the Province, although I have seen specimens, taken on the Busi river, in the collections of the Department of Agriculture at Beira.

*Chrysops longicornis*, Macq. A specimen in the Transvaal Museum bears the label "Pungwe Bay" (Beira harbour). I have never taken it myself.

*Tabanus africanus*, Gray. One of the commonest Tabanids throughout the Province. They appear in the largest numbers during October and are most often seen in the vicinity of rivers. Adults seem to be absent during the dry season. Although I have never seen them actually biting they are frequently numerous in pasture lands and stables.

*Tabanus biguttatus*, Wied. Found everywhere in the Province, most commonly near water; frequently seen in pasture lands and stables. Occurs throughout the year, but most abundant just before and during the early summer rains.

*Tabanus unitaeniatus*, Ric. I have never taken this species. It was described originally from specimens taken on the Pungwe River, near Beira.

*Tabanus ustus*, Walk. Specimens were taken in the vicinity of Lourenço Marques and on the Maputa River. It occurs during the early wet season but is never very abundant.

*Tabanus taeniola*, P. de B. This is the most common Tabanid in the Province of Mozambique, and in conjunction with its variety, *variatus*, Walk., it appears to be represented by more individuals than all the other species taken together. It is very abundant along streams, but is often found in houses and stables at some distance from water. Most numerous during December and January, but in the northern districts the species is found throughout the year. It also occurs in the Eastern Transvaal. Frequently bites severely.†

*Tabanus taeniola*, var. *variatus*, Walk. (*sagittarius*, Macq.) Found in company with typical *taeniola* throughout the Province; also found in the Eastern Transvaal and Southern Rhodesia.

* [Since Mr. S. A. Neave has succeeded in obtaining both sexes of the closely allied species, *Chrysops distinctipennis*, Aust., there can now be hardly any doubt that *C. fusca*, Ric., is the male of *C. stigmaticalis*, Lw.—Ed.]

† [Hundreds of specimens of this abundant and widely spread species have been received by the Entomological Research Committee from all parts of Tropical Africa. From these it appears that in West Africa the typical form greatly predominates, not more than from 5 to 10 per cent. of the specimens being referable to var. *variatus*, whereas in East Africa the proportions are almost exactly reversed. Although the extreme forms appear strikingly different, every intergrade can be found in a good series. The author had recorded the variety as a distinct species.—Ed.]

*Tabanus fraternus*, Macq. This species is not very common in Mozambique. I have only taken it a few times near Lourenço Marques and on the Zambesi River.

*Tabanus ditaeniatus*, Macq. Found practically throughout the Province, most commonly in the vicinity of streams or swamps. Frequents stables, houses and areas where cattle are grazing. Found throughout the year, but most numerous during the wet season. It is almost as abundant as *T. taeniola*. Occurs also in Eastern and Northern Transvaal.

*Tabanus fuscipes*, Ric. Several specimens of this species were taken at Umbelusi and on the Maputa River.

*Tabanus par*, Walk. Occurs practically everywhere in the Province, frequenting the same localities as *T. ditaeniatus*.

*Tabanus gratus*, Lw. This species was taken only twice, once at Umbelusi and once on the Lower Zambesi River.

*Tabanus tritaeniatus*, Ric. Specimens which are apparently referable to this species were taken twice in the Transvaal, but it was not met with in Mozambique.

*Tabanus minuscularius*, Aust. This species, recently described by Mr. Austen, was taken on the Umbelusi River, a few miles south of Lourenço Marques. It is not abundant.

*Tabanus producticornis*, Aust. This species, also lately described by Mr. Austen, was taken at the same place as the previous species ; only a single specimen was secured.

*Haematopota vittata*, Loew. This species was taken twice in Mozambique, once at Inyambane and once near Lourenço Marques, on mules and donkeys. It occurs also in the Central and Eastern Transvaal.

*Haematopota nociva*, Aust. This species was taken on cattle at Quelimane, and also at Lourenço Marques. It is probably found over the entire Province.

*Haematopota furtiva*, Aust. Collected at Umbelusi, Inyambane, and Komati-poort, on the Transvaal border.

*Haematopota decora*, Walk. Taken at Lourenço Marques in trains and on donkeys, and at Komati-poort and Maputa.

*Haematopota longa*, Ric. Taken at Umbelusi.

*Haematopota pertinens*, Aust. Found at Quelimane on cattle.

### Family **Trypetidae.**

*Ceratitis capitata*, Wied. This species is found in the southern part of the Province where it breeds in citrus fruits, peaches, guavas, pomegranates and other fruits. Cases are on record of intestinal myiasis, caused by the larva of this fly being swallowed alive.

*Ceratitis rubivora*, Coq. This species breeds in guavas about Lourenço Marques.

### Family **Tachinidae.**

*Auchmeromyia luteola*, F. This fly seems fairly common in the central and northern parts of the Province. I have specimens from Maganja da Costa, north of Quelimane, and from the Zambesi River ; it also occurs in the vicinity of Barberton, Eastern Transvaal.

*Auchmeromyia praegrandis*, Aust. This species was obtained in the Transvaal, but no observations were made as to habits.

*Cordylobia anthropophaga*, Grünb. Specimens of the larvae were taken from ulcers on a native at Lourenço Marques, in December 1908, and during the same month from ulcers on a dog. It is very abundant during certain seasons, when it becomes a severe pest to man in Mozambique and parts of the Transvaal.

*Chrysomyia chloropyga*, Wied. Taken from human faeces at Mt. Murrumbala, in October 1908.

*Chrysomyia putoria*, Wied. From Lourenço Marques, in February 1909, and from the Zambesi and Qua Qua Rivers, in December 1908.

*Chrysomyia marginalis*, Wied. Collected at Lourenço Marques and Maputo, in February and April.

*Lucilia sericata*, Meigen. Collected in houses at Lourenço Marques, Umbelusi and Pretoria.

*Sarcophaga africa*, Wied. This insect was collected on the beach at Chinde and also at Pretoria.

*Sarcophaga hirtipes*, Wied. From dwelling house at Bompona on the Zambesi River and also at Umbelusi.

*Sarcophaga imbecilla*, Karsch. Found at Umbelusi.

## Family **Muscidae.**

*Stomoxys calcitrans*, L. This species occurs practically everywhere in Mozambique where cattle are to be found. It is common about native kraals, as well as near towns and European settlements and plantations. Adults may be found at any time of year. The larvae breed abundantly in the refuse on the bottoms of cattle kraals, which is composed of droppings trampled down with cut grass and often becoming a moist compact mass, one to two or more feet deep. They are also often found in very wet cattle droppings. I have taken the fly in the following localities: Lourenço Marques, Maputa, Umbelusi, Komati-poort, Quelimane, Sabi, Mazanzane, Busi River, and Mt. Murrumbala. It is probably concerned in the transmission of trypanosomiasis of cattle in the regions where tsetse-fly does not occur and where this disease is prevalent. The native name in the vicinity of Beira is "dhongi."

*Stomoxys nigra*, Macq. This species is not at all common and seems to be least abundant in the southern districts. I have always taken it along with *S. calcitrans*. Collected at Maputa, Busi (near Beira), and at Mt. Murrumbala, Zambesi district.

*Stomoxys sitiens*, Rond. This species was taken at Bompona and Mt. Murrumbala, near the Zambesi River.

*Lyperosia minuta*, Bezzi. These little flies occur in small numbers in many parts of Mozambique. In February 1909, they were very numerous about the Municipal slaughter-houses at Lourenço Marques. I have also taken them in native cattle kraals at Ncanine, and near Beira and Quelimane. They seem to frequent cattle mainly.

*Musca domestica*, L. Found in houses and cattle kraals at Lourenço Marques, Umbelusi, and Mt. Murrumbala. Probably occurs throughout the year.

*Glossina morsitans*, Westw, Fly-belts are found in the following districts: Mozambique, Zambesia, Tete and the districts of the Companhia do Nyassa and Companhia de Moçambique.

*Glossina pallidipes*, Aust. Found in company with the previous species in the Zambesia district.

*Glossina brevipalpis*, Newst. Has been found only in one locality of the Zambesia district and in one region in the district of the Companhia de Moçambique.

The distribution of the species of *Glossina* has been discussed in a previous article in this Bulletin (vol. II, pp. 39–42).

### Family **Oestridae.**

*Gastrophilus equi*, Clark.

*Hypoderma lineata*, Vill. Specimens of larvae sent to Washington were pronounced by Mr. Nathan Banks as being identical with the larvae of this species.

### Family **Hippoboscidae.**

*Hippobosca rufipes*, Olf. This fly, while occurring commonly in the higher country of the Transvaal, does not seem to frequent the costal region to any extent, its place being taken by the following species.

*Hippobosca maculata*, Leach. Found everywhere in the Province. It is often very numerous and causes severe annoyance to cattle. I have taken it at Lourenço Marques, Komati-poort, Tossy, Umbelusi, Mambone, Beira, and about the Zambesi River.

*Lynchia rufipes*, Macq. Found on *Strix flammea* at Umbelusi, June, 1909.

*Echestypus paradoxus*, Newst. From an owl.*

*Lipoptena cervi*, L. Sent in from the Nyassa district; no host mentioned. Austen has recorded the species as having been found on a "duiker."†

[It seems desirable to take this opportunity of giving a complete list to date of the species of blood-sucking flies recorded from Portuguese East Africa, and therefore those which have not been referred to by Mr. Howard are added here.

In his "African Blood-sucking Flies," Mr. E. E. Austen records:—*Pangonia rondanii*, Bert., *P. rostrata*, L., *P. v-album*, Surc., *P. zonata*. Wlk., *Diatomineura pallidipennis*, Ric., *Tabanus liventipes*, Surc., *T. thoracinus*, P. de B., *T. subelongatus*, Macq., *Haematopota mactans*, Aust., and *H. niveipes*, Surc.; and subsequently Senhor J. de O. S. de Azevedo forwarded *Tabanus laverani*, Surc., to the British Museum, from Lourenço Marques.

Further, the Entomological Research Committee have received *Nyssorhynchus pharoensis*, Theo., and *Mucidus mucidus*, Karsch, from Lourenço Marques (*Dr. J. F. Sant' Anna*); and *Tabanus nyasae*, Ric., *T. maculatissimus*, Macq., and *Dorcaloemus compactus*, Aust., from the Zambesia District (*Dr. A. de Soveral*).—Ed.]

* [The occurrence of this species upon an owl is remarkable; normally, it is a common parasite on bushbuck and duiker.—Ed.]

† [When recording the single specimen thus obtained of this European species, Mr. Austen suggested that it might have been imported into the Transvaal with remounts, during the war, the insect having been obtained in February, 1901. It is more difficult to account for the occurrence of the species in Portuguese Nyassa.—Ed.]

# NOTES ON THE TSETSE-FLIES OF MURI PROVINCE, NORTHERN NIGERIA.

By Dr. J. Pollard, W.A.M.S.

(Map.)

As a general rule, on the Benue River and its tributaries, at least between Abinsi and Lau, the tsetses found are *Glossina tachinoides* and *G. palpalis*, the latter occurring far less frequently.

*G. tachinoides* is, in nearly all cases, associated either with the thick fringe of bush at the river-side ("kurimi"), or, where this is absent, with *Mimosa asperata*; both conditions being frequently present. Indeed, *Mimosa asperata* is practically an indication of the presence of *G. tachinoides* in the Province, as has been proved either by catching the fly or by obtaining evidence as to the impossibility of keeping horses or cattle in the neighbourhood.

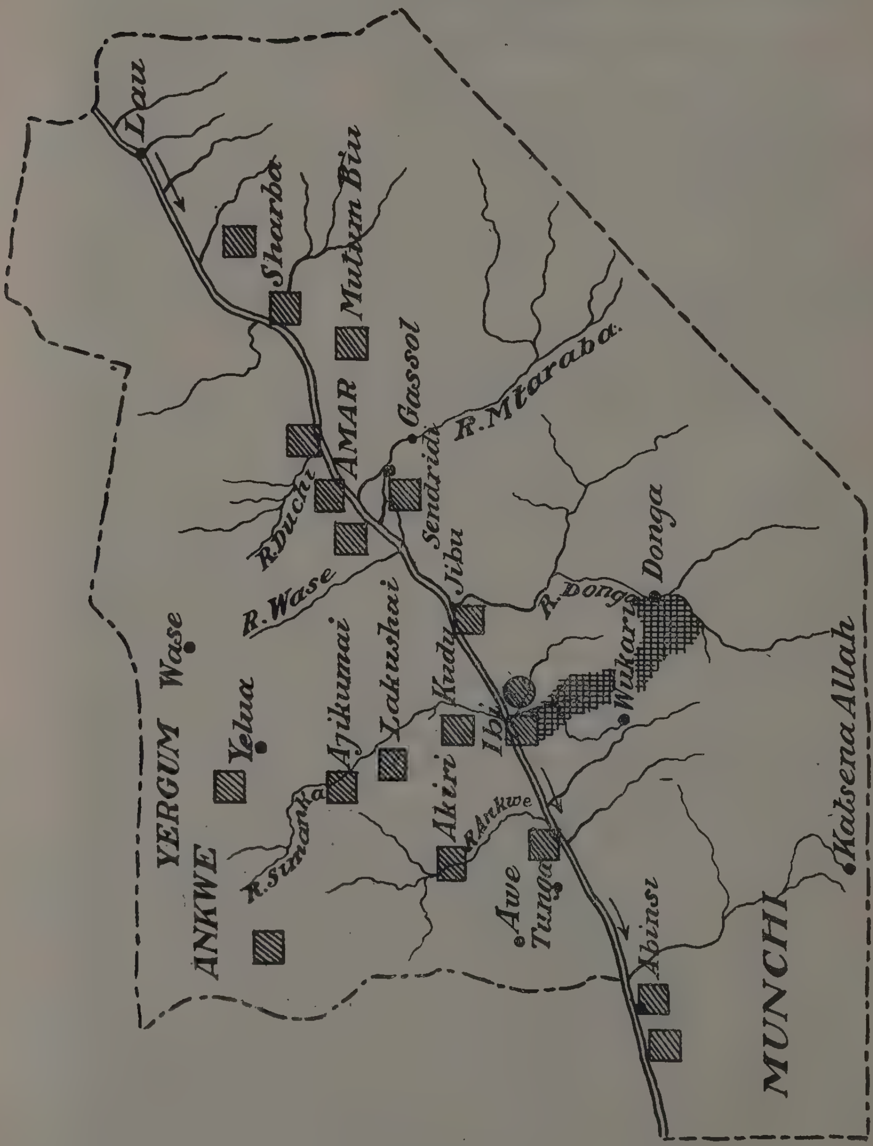
There are, however, several exceptions, one of the most remarkable being Gassol on the Mtarraba River, where cattle and horses are kept all the year round, although the *Mimosa* is plentiful on a partially swamped island in the river below the town. This marsh would be a typical tsetse-haunt in nine out of ten places in the Province.

At Ibi, the Provincial Headquarters, *tachinoides* and *palpalis* are found on the river and in the swamp adjoining the river, and here *Mimosa asperata* is plentiful. Ibi is built on a ridge, and there is a swamp at the back of the ridge, as well as that in front which adjoins the Benue. Curiously enough, this back swamp is practically free from the *Mimosa*, and *tachinoides* is rarely found here though *morsitans* is common.

The distribution of *morsitans* in the "hinterland" of the river extends as far back as a stream near Wukari, which town is at present an island of fly-free land in a sea of tsetse. Beyond Wukari to Donga, on the river of the same name, *morsitans* is found. The flies usually attach themselves to any party that may be crossing one of the small shady streams. Along this road *morsitans* is usually associated with a *Haematopota*.

This *Glossina* has a peculiar habit of flying behind the natives, close to and on a level with their ankles. It frequently settles on the ground for a rest, and, incidentally, it is by no means easy to stalk with a net, being difficult to see, even though the background is generally yellowish. When flying near the ground the abdomen of the fly hangs down nearly vertically and the dorsal surfaces of the wings, as seen from behind, look upwards and a little backwards. The fly makes constant flanking and rear attacks on its victims.

Sleeping sickness epidemics have undoubtedly taken place in the past. Abinsi was decimated about 20 years ago, and I had great difficulty in persuading the people of Wukari, who are of the same race—Jukun—as those at Abinsi, that they ran no risk in their fly-free town from the presence of a few persons suffering from sleeping sickness whom I had sent out of Ibi, in order that they should be away from a *palpalis* area. The smaller villages along the Benue often




SKETCH-MAP OF MURI PROVINCE, NORTHERN NIGERIA, showing the distribution of *Glossina*.

contain one or two cases of rather chronic trypanosomiasis, which is undoubtedly endemic along this river.

As before said, the fly on the river is chiefly *tachinoides*, but with this, in localised patches and in far smaller numbers, is associated *palpalis*. Practically the entire fringe of the river in the Province is full of *tachinoides*, and a canoe journey at certain points is extremely uncomfortable. The fly seems to be a master in flanking tactics and to possess a diabolical ingenuity in waiting to attack till the attention of its victim has been distracted from its presence.

At Ibi, in spite of much clearing, *tachinoides* is very annoying in the bungalows, It is noted particularly that when a native with a dark gown comes to the house, he leaves a *tachinoides* behind him. This happens even if he be met outside the house by some servant, as the fly will follow the latter into a shady room.

From the middle of December to the middle of May the fly is much less troublesome, but it is never quite absent from the bungalows or offices, and it can always be found in the marsh near the river.

With regard to the extension of the fly-areas, it seems probable that localities previously free are becoming infested, and that in 1911 the tsetse along the Benue, in Muri Province, were more numerous than they have recently been.

There is in the Munshi Division, and in the northern part of the Province, a small black breed of cattle which is apparently immune to tsetse. At any rate these cattle can be kept in the Munshi district where no horses can live and where imported Fuhlani cattle all die. I have not yet obtained any blood-films from these animals.

It is interesting to note that the Munshis are great hunters and that they have practically destroyed all the wild game in their district, and yet, in spite of this, the trypanosomiasis of cattle and horses is rampant. Native dogs and European cats also suffer from this disease.

Doctors Flood, Watson, and others have toured the Munshi Division and have, I believe, shown that *tachinoides* is the most common of the tsetse-flies there found.

In the accompanying sketch-map the squares indicate the presence of *G. tachinoides*, while *G. palpalis* is indicated by a circle and *G. morsitans* by irregular hatching.

# TABANIDAE ATTRACTED BY SCALE-INSECTS.

Dr. J. W. Scott Macfie, Medical Officer at Ilorin, Northern Nigeria, has made the interesting observation that a tree attacked by a Coccid of the genus *Ceroplastes* served as a strong attraction to several species of TABANIDAE, including both males and females. He writes :—

" I am sending a small lot of flies representing exactly a week's collecting from one small 'Chedia' tree in my compound, which I have just discovered to be an abundant source of biting flies. The 'Chedia' is very common all over the country; it exudes quantities of milky latex on the slightest injury, and bears small reddish-yellow berries, but I do not at present know its scientific name. In my compound I have several young trees of this species, but the one on which all these flies were taken differs from the others in being heavily infested with a species of scale-insect. It is quite a small tree, not more than 14 feet high, and the largest of its branches is only 2½ inches in diameter. The surface of all the branches is more or less covered with old scales, and on the young growing shoots there are fresh scales that attract swarms of ants, which march in columns up the tree-trunk all day long. The flies, however, are never seen on these young shoots; they always appear suddenly and silently on the large branches over which they crawl, slowly moving their fore feet to and fro laterally, as though they were sweeping invisible atoms into the middle line under their probosces, which every now and then they bend down, appearing to be feeding. So engrossed are they that it is almost possible to catch them by hand.

" I see, in the Sleeping Sickness Bulletin (No. 36), in the review of a paper by Prof. Hine on North American TABANIDAE, that 'many species of the family TABANIDAE have been observed feeding on the excretions of insects' such as 'aphides, scale-insects and Hemiptera.' One male (*Tabanus gratus*), which I dissected, had its stomach full of small yellow bodies which did not stain with Giemsa's solution. The flies are only to be found on the tree in the day-time, and especially when the sun is shining; I have never found them on the branches at night.

" It is noteworthy that my pony, tethered not 20 yards away, was quite unmolested by flies at the very times when I was catching considerable numbers on this 'Chedia' tree. Indeed, until I observed this source I was able to get but few specimens of biting flies here (Ilorin). It is, perhaps, a danger to have such a tree in the vicinity of a house or stable, on account of its influence in attracting blood-sucking insects, although the majority of the flies may prefer the diet found on the tree to the meal of blood afforded by the horse."

The specimens sent by Dr. Macfie comprised sixty TABANIDAE, referable to the following six species :—

| | ♂ | ♀ |
|---|---|---|
| *Tabanus pluto*, Walk. ... ... | 1 | — |
| " *biguttatus croceus*, ~~Wied.~~ ... Surc. | 3 | 3 |
| " *taeniola*, P. de B. ... ... | 9 | 11 |
| " *gratus*, Lw. ... ... | 15 | 6 |
| " *laverani*, Surc. ... ... | 3 | 4 |
| *Haematopota sp. nov.* ... ... | 3 | 2 |

The males of *T. biguttatus croceus* and *T. laverani* had not been previously recorded.

Prof. R. Newstead, F.R.S., has kindly identified the scale-insect which attracted the flies as *Ceroplastes egbarum*, Ckll. (*africanus*, Green). The species was originally described from Abeokuta, in Southern Nigeria, but appears to be widely distributed in Africa. Prof. Newstead remarks that "many of the Lecaniinae, of which *Ceroplastes* is a member, secrete a kind of 'honey-dew' that is attractive to insects, especially Hymenoptera; and in Great Britain all the species of the genus *Vespa* are particularly fond of the secretion."

## COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st January and 31st March, 1912).

Dr. W. M. Aders :—3 Culicidae, 63 other Diptera, 38 Hymenoptera, 13 Coleoptera, 9 Lepidoptera, 2 Lepidopterous larvae, 29 Rynchota, and 2 Orthoptera ; from Zanzibar.

Mr. E. Ballard :—7 Tabanus ; from Nyasaland.

Mr. John R. Bovell :—6 *Phytalus smithi*, Arr. ; from Barbados.

Mr. E. H. Brogan :—15 *Amblyomma cohaerens* ; from Uganda.

Dr. R. Bury :—128 *Tabanus*, 49 *Glossina*, 1 *Auchmeromyia*, and 15 other Diptera ; from Fort Johnston, Nyasaland.

Dr. T. J. Cobbe :—16 *Tabanus*, 4 *Glossina*, 1 *Auchmeromyia*, and 5 Hippoboscidae ; from Uganda and British East Africa.

Mr. E. Costley-White :—194 Lepidoptera ; Mlanje, Nyasaland.

Dr. H. Lyndhurst Duke :—2 *Tabanus*, 1 *Simulium*, 1 *Lyperosia* 4 *Stomoxys*, and 6 other Diptera ; from Uganda.

Mr. E. Dayrell :—59 *Tabanus* ; from Ikom, Southern Nigeria.

Mr. W. C. W. Eakin :—17 *Tabanus combustus*, 2 *Chrysops silacea*, 4 other Diptera, 46 Hymenoptera, and 3 Lepidoptera ; from Kwa-Ibo, Southern Nigeria.

Mr. T. E. Fell :—2 *Tabanus*, 7 *Glossina*, and 1 Coleopteron ; from Western Ashanti.

Capt. A. D. Fraser :—1 *Glossina*, 25 Hymenoptera, 19 Coleoptera, and 3 Rhynchota ; from Entebbe, Uganda.

Dr. Mercier Gamble :—2 Culicidae, 5 Tabanidae, 1 *Glossina*, 4 *Stomoxys*, 1 *Auchmeromyia*, and 43 Ticks ; from Portuguese Congo.

Dr. A. D. P. Hodges :—3 Culicidae ; from Entebbe, Uganda.

Dr. E. Hopkinson :—23 *Glossina morsitans* ; from Gambia.

Dr. A. Ingram :—403 Culicidae, 137 Culicid larvae, 3 *Tabanus*, 3 *Haematopota*, 1 Stratiomyid, 5 Stratiomyid larvae, a plant associated with *Mansonioides* larvae, and 2 small Fish ; from Bole, Northern Territories, Gold Coast.

Dr. W. J. D. Inness :—17 Culicidae, 24 *Tabanus*, 12 *Glossina*, 1 other Dipteron, 12 Mallophaga, and 443 Ticks ; from Northern Nigeria.

Mr. Ll. Lloyd :—2 Diptera, 4 pupa cases of *Glossina morsitans*, and 2 Rhynchota ; from North Eastern Rhodesia.

Dr. J. W. Scott Macfie :—6 Culicidae, 38 *Tabanus*, 4 *Haematopota*, 19 *Glossina palpalis*, 5 *Stomoxys calcitrans*, 1 *Cordylobia*, 16 other Diptera, 2 Hymenoptera, 11 Coleoptera, 84 Lepidoptera, 3 Planipennia, 11 Odonata, 2 Rhynchota, and 1 Orthopteron ; from Zungeru, Northern Nigeria.

Dr. R. E. McConnell :—7 Culicidae, 33 *Tabanus*, 13 *Haematopota*, 147 *Glossina*, 1 *Simulium*, 1 *Stomoxys*, 1 *Lyperosia*, 18 other Diptera ; from Nile Province, Uganda.

Dr. C. H. Marshall :—1 *Tabanus*, 13 *Glossina*, 2 *Stomoxys*, 3 *Auchmeromyia*, 1,000 Siphonaptera, 6 other Diptera, 15 Hymenoptera, 138 Coleoptera, 67 Rhynchota, 9 Orthoptera, 37 Mallophaga, 53 Anoplura, 3,649 Ticks, and 46 Mites ; from Uganda.

Dr. T. F. G. Mayer :—55 Culicidae, 1 *Haematopota*, and 5 Ticks ; from Southern Nigeria.

Dr. B. Moiser :—75 Culicidae, 41 *Glossina*, 15 *Stomoxys*, 3 *Lyperosia*, and 1 Asilid ; from Geidam, Northern Nigeria.

Dr. J. C. Murphy :—200 Culicidae, 34 *Tabanus*, 1 *Thaumastocera*, 2 *Simulium*, and 18 *Glossina* ; from Daru, Sierra Leone.

Mr. S. A. Neave :—76 Culicidae, 32 Chironomidae, 1,867 Tabanidae, 162 *Glossina*, 268 *Glossina* pupae, 80 *Lyperosia*, 15 *Stomoxys*, 1 *Auchmeromyia*, 4 Hippoboscidae, 136 other Diptera, 29 Siphonaptera, 24 Hymenoptera, 15,545 Lepidoptera, 3 Coleoptera, 4 Planipennia, 8 *Bittacus*, 2 Odonata, 3 Orthoptera, 16 Rhynchota, 173 Mallophaga, 54 Anoplura, 1,065 Ticks, 72 Mites, 5 other Arachnida, and 2 worms ; from Uganda.

Dr. H. T. Palmer :—50 Culicidae, 18 *Tabanus*, 2 *Glossina*, 2 *Auchmeromyia*, 2 other Diptera, 44 Hymenoptera, 29 Coleoptera, 6 Lepidoptera, 26 Rhynchota, 10 Orthoptera, 2 Anoplura, 46 Ticks, 6 Mites, 12 other Arachnida, and 1 Millipede ; from the Gold Coast.

Mr. R. Paske Smith :—6 *Lyperosia*, and 103 Ticks ; from Uganda.

The Principal Medical Officer, Nairobi :—43 Ticks ; from Nairobi, British East Africa.

Miss Muriel Robertson :—7 Rhynchota ; from Uganda.

The Royal Society's Sleeping Sickness Commission (collected by Dr. G. D. H. Carpenter) :—4 *Glossina* and 76 pupa-cases of *Glossina* ; from Uganda.

Capt. A. C. Saunders :—16 *Tabanus*, 6 Hippoboscidae, 6 other Diptera, and 4 Hymenoptera ; from near Lake Rudolph, British East Africa.

Mr. S. W. J. Scholefield :—18 Hymenoptera, 18 Coleoptera, 3 Lepidoptera, 17 Orthoptera, 12 Rynchota, a number of Cassidid larvae, and 1 wasps' nest ; from Kitui, British East Africa.

Mr. R. J. Stordy :—9 Culicidae, 15 *Tabanus*, 9 *Haematopota*, 11 *Glossina*, 14 *Stomoxys*, 19 *Lyperosia*, 26 Hippoboscidae, 954 other Diptera, 929 Hymenoptera, 244 Coleoptera, 23 Lepidoptera, 148 Rhynchota, 13 Odonata, 8 Orthoptera, and 399 Ticks ; from British East Africa and Abyssinia.

Dr. E. C. Strathairn :—1 *Stomoxys*, 2 other Diptera, 64 Cimicidae, 8 other Rhynchota ; from Uganda.

Dr. R. Van Someren :—13 Dipterous larvae, a number of Coccidae, 1 Louse, and 3 Ticks ; from Uganda.

Dr. Antonio de Soveral :—8 *Tabanus*, 2 *Glossina*, and 51 other Diptera ; from Portuguese East Africa.

Dr. C. A. Wiggins :—11 *Chrysops*, 3 other Diptera, 229 Hymenoptera, 415 Coleoptera, 9 Lepidoptera, 7 Orthoptera, and 285 Rhynchota ; from Uganda.

# NOTES ON TSETSE-FLIES AND ON PROPHYLACTIC MEASURES AGAINST SLEEPING SICKNESS IN THE WESTERN PROVINCE OF ASHANTI.

By T. E. Fell,
*Provincial Commissioner, Ashanti.*

*Glossina fusca* and *G. palpalis* are prevalent throughout the Western Province of Ashanti, the latter being much the most common species. They both occur in dense jungle, but the type of bush most favourable for them appears to be the scrub and smaller forest which occurs in the dividing line of country between the dense jungle and typical "orchard" grass bush. Scrub of a height of three or four feet upwards appears to be sufficient to harbour these insects.

*G. pallicera*, of which a fair number of specimens were captured during the year, appears under conditions similar to those favourable to *G. palpalis*, but is far more uncommon than either that species or *G. fusca*.

Although all these flies may be more prevalent in the immediate neighbourhood of water, I have constantly observed them far removed from water, or where water-courses and water-holes have been dry for many weeks. In all localities during the rains, roughly from April to November, water and swamps are plentifully scattered over the whole country.

*G. longipalpis*, a common species, is prevalent in the "orchard" grass bush and has been observed at considerable distances from water; nor does it apparently require the shade necessary to *G. palpalis*. I have, however, captured this species in forest, but never far removed (300–400 yards) from grass areas.

## Seasons of prevalence.

The genus *Glossina* practically disappears from December to the end of March, though a few odd specimens may be seen during that period. In my diary I find the entry, "26th and 27th March; two or three *Glossina* seen—the first for some months." The first heavy rain showers of February and March, which produce *Haematopota*, *Hippocentrum* and *Tabanus* in numbers, do not seem to affect the appearance of *Glossina* to any great extent, and it is not till the rains are more thoroughly established that *Glossina* appear to emerge. They are then prevalent, though never in very great quantities, throughout the rains till the dry season is well established and do not appear and disappear in thousands as do the broods of the above-mentioned Tabanidae.

## Clearing at Sunyani.

At Sunyani an effective clearing of 300 to 700 yards round the European quarters has been made with much labour and at considerable expense. Certainly, to a great extent, tsetse-flies have disappeared from this clearing, but it is usual during the rainy months for odd ones to appear almost daily in the European quarters. The constant labour of 30 to 50 men a day, apart from military assistance, is required to keep this clearing effective during the rains and to increase it during the dry season. Doubh grass has been planted over

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this area, and this should eventually render the clearing effective and reduce the cost of maintenance. Many years of continual weeding, planting, &c., will be necessary before this result can be attained. In the dry season, as already stated, the fly naturally disappears almost entirely. In the rains, scrub and elephant-grass grow at such a rate that constant daily labour is required to keep the ground in such a condition as to render the harbouring of *Glossina* impossible. This land was originally elephant-grass, rank grass, scrub and "orchard" trees, and it was not a question of clearing dense jungle, with which I shall deal later. The planting of doubh grass over a forest clearing would be an infinitely more difficult business than in the type of clearing at Sunyani.

In spite of considerable efforts, I think that only two *Glossina* pupae have been found at Sunyani by the medical officers.

## Forest Clearing.

Clearings round villages (800 yards has been mentioned), round water-supplies and at river-crossings on roads, have been advocated and instructions have been sent to administrative officers to have such clearings made; but in order to carry these measures into effect, it would be necessary to bring some compulsion to bear upon the native population.

From personal observation I am satisfied that a forest clearing, not effectively maintained, *produces a scrub-growth which is more favourable to tsetse-flies than the forest itself.* In the rains, the season when the fly is prevalent, this secondary scrub grows at an enormous rate and cannot be coped with, except with constant and extensive labour. It is, to my mind, eminently undesirable to attempt to compel a clearing larger than can be effectively maintained. In this matter it is easy to produce a condition of affairs which might conceivably be more dangerous to the population than that which has hitherto existed.

The villages are small—populations of 500 to 1,500 or so—and I doubt whether it would be practicable or possible for such a population to maintain effectively a clearing even approximating to present requirements. It must also be remembered that the season of prevalence, when clearing is most required, is the farming, the rubber, and the snail season. It has been suggested that farms should be made in the immediate vicinity of villages. I consider the only local crop which would give thoroughly effective results would be ground-nuts, and this is a product more of the open country than of the forest. Ground-nuts are not grown, in Ashanti, for two successive years on the same ground. They require a shallow gravelly or sandy soil, and are unsuitable as a forest product. Sweet potatoes would no doubt be efficacious to some extent, but they are strongly objected to by the natives on account of their rapid and spreading growth, and they are said, with what truth I am unable to state, to afford a special attraction to snakes.

## Clearing round Water-supplies.

General instructions have been issued to obtain clearings round village water-supplies; but it is now generally recognised that, where these supplies are the sources of streams, the removal of shade may have the effect of diminishing the

water, if not actually drying it up altogether during the dry season, and infinite harm might be done thereby to a large extent of country watered by a particular stream. In Jaman and Berekum, water in the dry season is very scarce, water-holes being mostly used as village supplies. These holes are situated in shady places and to remove this shade might mean the end of the supply and consequent water famines during the dry season. Clearings round water-supplies should therefore be undertaken, I think, with great care, and the supply should be examined by an expert before clearing operations are definitely ordered and enforced.

### River-crossings.

To maintain an effective clearing at river-crossings on forest roads, situated as many are at considerable distances from the nearest village, I consider, however desirable, to be altogether impracticable, unless undertaken at great expense by Government labour. In the neighbourhood of rivers vegetable growth is especially rapid, and a non-effective clearing would possibly create a forest condition more favourable to *Glossina.* I venture to think that at the present time the limited occurrence of sleeping sickness in the Province would not warrant large expenditure in this direction.

### Sleeping Sickness.

From medical reports and from native evidence, sleeping sickness appears to be a disease of great antiquity in the locality. I can find no record or tradition of an epidemic, and it would appear unlikely that there is any great danger, at the present moment or in the near future, of an outbreak in epidemic form. From recent statistics the percentage of infection (not a very large one) appears to be in a condition of equilibrium. There is no native panic, and from my own experience of seven years of being constantly bitten by *Glossina* in infected areas, the risk of infection cannot be very great. There is no evidence to show that the disease is any more prevalent at the present time than it has been for a long period, and several years of medical statistics will be necessary to enable any correct opinion on this point to be formed. In the present condition of the disease the object of enforcing clearings would not be understood by the natives, and with such a small percentage of infection no great object lesson would be conveyed by results. It is possible that the natives would conceal cases of the disease (and there is nothing easier for them to do) and let the Government know as little about it as possible, with a view to avoiding labour the cause of which they do not appreciate. Were there a panic or a much larger percentage of infection, conditions would be different. Three years ago the natives were willing and anxious, as I think has been testified by Dr. Kinghorn, to aid the cause of science by giving all information in their power. Already, I regret to say, I see signs of attempted concealment and a desire to avoid answering questions as to the disease.

### Glossina longipalpis.

According to medical reports, Jaman, Berekum and Wenchi are the neighbourhoods most heavily infected with sleeping sickness. In these areas *Glossina*

*longipalpis*, in the grass country, is equally prevalent with *G. palpalis* in the bush, yet in other parts where *palpalis* occurs and *longipalpis* does not, the percentage of infection appears to be less. *G. morsitans* has been proved to be a carrier in Rhodesia of a form of trypanosomiasis extremely similar to sleeping sickness and it is more than probable that *G. longipalpis* may equally be a carrier in the Western Province of Ashanti. Till this point is definitely settled one way or the other by scientific experiment, it would appear premature to direct compulsory and expensive prophylactic measures against *G. palpalis* alone, whose habitat differs so much from that of *G. longipalpis*.

## Conclusions.

To sum up my observations and conclusions, I would urge :—

1. That the native should be encouraged to report cases of sleeping sickness for diagnosis and treatment, and to give evidence, and should not be frightened by excessive compulsory work into concealment of the disease.

2. That the population is not sufficiently large to maintain extensive effective clearings.

3. That a non-effective clearing of forest produces a condition probably more dangerous than no clearing at all.

4. That clearing round water supplies should only be undertaken with the greatest caution.

5. That clearings at river crossings in forest are impracticable unless undertaken with Government-paid labour, and that the cost of clearing and maintenance is not at present warranted, owing to the limited occurrence of sleeping sickness.

6. That the point as to whether *Glossina longipalpis* is or is not a carrier of human trypanosomiasis should be definitely settled as soon as possible by transmission experiments.

If the scientific investigation referred to in the last paragraph be undertaken in the locality, I do not consider that at present any steps are required from the Administration beyond :—

1. Treatment of cases and obtaining of statistics as to sleeping sickness.

2. Instruction of the native as to causes of the disease ; my own experience is that if one tells a native the same thing for a sufficient number of years he will end by believing it.

3. Improvements in general sanitation and in the native methods of living.

4. Object lessons of extensive effective clearings round *European* stations.

5. Up-keep of village clearings of *such extent only as can be effectively maintained* by the population without interfering with their farming and industrial pursuits. The extent of these clearings must be largely left to the discretion of the administrative officers, who would, of course, take the medical officer into consultation.

During this period I presume the medical authorities would obtain statistics with regard to the disease, which in a few years would yield definite data to proceed upon, and further steps could be taken by the Administration should any marked increase of sleeping sickness be demonstrated.

I should mention that throughout the "orchard" country small antelope (bushbuck, duiker, etc.) are plentiful, and that in unfarmed and thinly populated areas buffalo, waterbuck, hartebeest, roan antelope, kob and reedbuck are found. Pig, bongo, and smaller forest antelope are found in the forests, and all rivers of any appreciable dimensions contain crocodiles. Elephants occur in one portion of Jaman and Wenchi, and during the rains in the Akonanza Forests of Wam and Ahafo. Monkeys are plentiful in the forest and baboons in some parts of the open country. Game generally is fairly plentiful, but to the European hunter it is extremely difficult of approach, its shyness being doubtless due to the large amount of native hunting and the profusion of Dane guns in the country.

# NOTES ON GLOSSINA MORSITANS, WESTW., IN THE LUANGWA VALLEY, NORTHERN RHODESIA.

By Ll. Lloyd.

*Entomologist to the Luangwa Sleeping Sickness Commission.*

These notes are intended as a summary of the early investigations into the habits of *Glossina morsitans* carried out in connection with the Luangwa Sleeping Sickness Commission. The part of the valley that has been examined is that lying between 12° S. and 13° 50′ S., but it has been practicable to make only one journey to the eastern side of the river. This journey was undertaken in September and consisted of an examination of the Rukususi and Rukusi Rivers from the Luangwa almost to the Nyasaland boundaries. Hence these remarks apply mainly to the district immediately surrounding Nawalia, the headquarters of the Commission. The observations have been made during the period from August 1911 to the beginning of March 1912.

## Physical features and climate.

These have been dealt with on several occasions,* but a few remarks here are necessary. The Luangwa is a broad sluggish stream running through an alluvial plain, at this point about thirty-five miles in breadth. In the dry season there are extensive sand-banks in its bed. On the western side low hills arise at the edge of the plain and the range is continued to the precipitous Mchingas. The laboratory is situated on the first of these hills, at an altitude of 2,000 feet, while the Luangwa is about 100 feet lower. The hills are interspersed by shallow hollows filled with alluvial soil, through which the streams cut deep channels. Apart from the Nyamadzi and the Mpamadzi, which are perpetual streams, these channels contain no water, except for a few hours after rain, when they assume the proportions of torrents. On the eastern side there is no running water during the dry season, the beds of the streams becoming filled with a dense growth of spear-grass. The whole valley from June to December is very dry. A few hot salt-springs in the neighbourhood of Nawalia form permanent swamps of small proportions and near the Luangwa a few pools persisted until the rains began. The ground is baked so hard that it becomes difficult to penetrate it, and in the plains broad and extensive fissures form which extend deeply into the earth. In the rainy season the plains become very swampy, swamps being common on sloping ground in the hills where the short tufty grass retains the water for days after rain has fallen.

The vegetation for the most part is not dense. The mopani forest, which extends over most of the plains, is of an open nature with little or no undergrowth. It consists almost entirely of one kind of tree, the mopani (*Copaifera*

* Neave, Bull. Ent. Res. I, p. 303.

*mopani*), with occasional baobabs (*Adansonia digitata*). The ground is scantily clothed with short grass. In places where the swamps are of too long duration for the growth of trees are found stretches of long grass which is fit to burn about September. On the hills, where the woods are less open and composed of various trees, there is denser undergrowth, but it is rarely of an impenetrable nature.

Details of the temperatures experienced and of the humidity of the air are given elsewhere.

## Distribution of Glossina morsitans.

*G. morsitans* is the only species of tsetse-fly that has been met with. It is almost universally distributed in this part of the valley, but in the immediate vicinity of the Luangwa itself it is not often seen.* Dr. Aylmer May informed me that in a long journey up the river he was much struck by this fact. On one occasion my carriers were much bothered by this fly from Nawalia to the Luangwa, but it did not cross the river with us, and on returning next day to the western side I was unable to find a single specimen in several hours search. The only piece of country that is apparently always clear of fly is a triangular patch extending from the big village Kambwiri to the Luangwa.† I observed nothing in the nature of the vegetation or soil to account for this absence, and game of all kinds is very plentiful in this district. This locality has always been clear of fly so far as we are aware.

## Seasonal variations.

The fly was very numerous in the valley during the early part of the dry season, but the numbers gradually decreased to the commencement of the rains, when increase was again observed. This corresponds with the numbers of pupae that were obtained in the laboratory. No special decrease was observed at the time of the grass fires. In August the fly was rather numerous on the road from Mpika to the foot of the Mchingas, the first being seen about eight miles from Mpika; but on returning by this road in March I saw no fly on this section. The weather on both occasions was ideal for fly.

At the beginning of March I went to the higher ground of the Congo-Zambesi watershed to recommence breeding tsetse in a fresh locality. The site selected is at Ngoa, thirty-two miles N.E. of Mpika, and with an altitude of about 4,000 feet. The spot was reached towards the close of the rains and *G. morsitans* was extremely scanty. The natives of the district affirmed however that as soon as the rains ceased the fly would become numerous. During the first week rain fell nearly every day but after this the weather continued fine. The increase of the insect has been most remarkable and is well shown by the following catches of three expert fly-boys. During the first week the boys brought in 38 females, during the second 71, and during the third 147.

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* Neave, Bull. Ent. Res. I, p. 306.

† Hall, Bull. Ent. Res. I, p. 183.

## Habits.

In the valley the fly becomes active at sunrise, if there is no dew, disappearing during the hottest hours of the day, except in deep shade. Directly it becomes cooler the fly recommences to bite and continues to do so till some time after the sun has set. When a lamp was taken at night into the room where the captive flies were kept they immediately became active. Individuals occasionally flew on to our verandahs in the evening and attempted to feed by lamp-light. At Ngoa, where the mornings are at present cold with heavy dews, the fly does not become active till the sun has been up for two or three hours. They may be seen resting on the trunks of trees and are very wary if approached. They continue to bite throughout the day but are most troublesome between the hours of 4 and 5 p.m. As a rule the tsetse disappear during a shower, but on one occasion when I walked for an hour in heavy rain they continued to bite all the time. They bite readily through one thickness of clothing and if no jacket is worn the shoulders are badly attacked. However hot the weather this garment should always be worn in fly country. It is advisable also to have the bottoms of the trousers closed as the flies often enter and bite above the socks. Tight thin clothing is much to be deprecated and the ideal clothing consists of boots, thick puttees and loose knickerbockers.

## Proportion of the sexes.

Much difficulty was experienced at first in obtaining sufficient females for breeding purposes. Frequently only three or four females were brought in amongst two or three hundred males. Later the boys were shown the differences between the males and females and there was then no difficulty in obtaining a sufficiency of the latter. The relatively small proportion of females that is normally taken is a matter of great interest. In the laboratory the sexes are bred in equal numbers, so that it is fair to assume that they are really equal in nature. Several writers have drawn attention to the fact that the swarms of tsetse which accompany a moving object leave it as soon as motion ceases.* While this is certainly the case, yet flies which desire to feed do not leave a standing animal and one is very frequently bitten when standing or sitting. The majority of the swarm however are not desirous of feeding and may often be seen settling on the cover of a machila,† though the helpless backs of the bearers offer tempting opportunities for a meal. If the flies which actually bite are caught they are found to be females as frequently as males, but the small proportion of females that is caught normally shows that the swarm consists almost entirely of males. An analogous case may be quoted. The vast swarms of midges so often seen on fine evenings are known to consist entirely of males, and directly a female joins the swarm it is mated and the couple drop from the dance. With *Glossina*, as long as an animal is moving there is a probability of females

* Montgomery and Kinghorn, Ann. Trop. Med. and Paras. III, p. 325. Other writers have made the same observation about *G. palpalis*.

† [A kind of sedan-chair —Ed.]

rising to feed and of the accompanying males thus finding mates. When the animal stands there is little chance of females rising to it and this may be the reason why the males leave. Mating couples have several times been seen on the backs of natives.

## Food.

Owing to the difficulty of obtaining suitable mammals, native fowls were used almost entirely as blood donors for the captive flies. The small numbers of pupae obtained would seem to indicate that fowls' blood is not a very suitable food. This is perhaps because the blood forms large firm clots in the sucking stomachs of many of the flies. When the blood has attained this condition it cannot apparently be utilised by the flies, as the clots persist for some weeks after the meal on fowls, though monkeys may have been used as food in the interim. When such a clot is formed it would be impossible for the fly to retain a full-grown larva in the uterus. The phenomenon has not been observed with mammals' blood, nor has it been observed in nature.

No evidence has been obtained that the flies take any food other than blood. Out of sixty-seven freshly caught flies that were dissected, mammalian blood was recognised in fifteen, nucleated red cells in four; one fly contained both nucleated and non-nucleated red cells; in thirty-two, blood in a more or less digested condition was seen; while fifteen had either not fed or the detritus was not recognisable.

It seems possible that a little water may be taken, as the flies have been observed at the edges of puddles and apparently drinking. Kinghorn has observed the same thing with *G. palpalis* on the shores of Lake Tanganyika. If a moistened sponge or blotting paper is placed in a bottle with captive flies, they will settle on it and thrust in their proboscides. I have not been able to prove by supplying coloured fluids and subsequently dissecting the flies that fluid is actually absorbed. Exactly the same thing was observed with slices of ripe water melon but again it could not be demonstrated that food was taken up. Flies placed in bottles with Sphingid larvae died of starvation and were never seen to take anything but the most perfunctory interest in the caterpillars.

A gecko which was placed in a cage of flies caught and devoured the insects. Experiments were also made with a monitor which was placed in the double bottom of a cage made of gauze in such a manner that it was incapable of movement. The flies in the cage attempted to feed but only one succeeded in doing so, thrusting in its proboscis in the region of the head. The animal was then killed and a cut section was offered to the flies, when several readily gorged themselves.

## Enemies.

An Asilid fly was taken on the wall of the laboratory devouring a tsetse-fly; it had made a wound in the side of the thorax. The favourite food of these rapacious insects seems to be TABANIDAE, especially the larger species. One was taken eating a dragon-fly.

During the latter part of August the laboratory was raided during the night by hordes of a red driver-ant. These climbed the bottles in which the tsetse-flies were kept, bit through the gauze, and entering destroyed every fly. The bottles in which the pupae were kept were also entered but the pupae were not damaged. A still active larva also, curiously enough, escaped injury. This incident is not recorded as suggesting that driver-ants are enemies of the flies in nature, but as a record that the larvae and pupae are not destroyed by these insects.

*Table showing the duration of the pupation period of* G. morsitans *at various temperatures (altitude* 2,000 *ft.).*

| Period during which the pupae were obtained. | Number of apparently healthy pupae. | Number of pupae from which flies emerged. | Average duration of the pupation period in days. | Mean temperature in laboratory. | Approximate mean temperature to which the pupae were exposed. | Relative humidity of the outside air. |
|---|---|---|---|---|---|---|
| June 27–30 | 3 | 3 | 51·0 | — | 67° | 48·6 |
| July 1–15 | 6 | 5 | 46·6 | 64·1° | 70° | 45·7 |
| „ 16–31 | 24 | 18 | 38·7 | 68·3° | 71° | |
| Aug. 1–15 | 21 | 9 | 35·5 | 69·4° | 73° | 35·8 |
| „ 16–31 | 5 (?) | 1 | 33·0 | 73·0° | 76° | |
| Sept. 1–15 | 2 | 2 | 25·0 | 72·7° | 82° | 31·5* |
| „ 16–30 | 14 | 12 | 24·5 | 80·7° | 83° | |
| Oct. 1–15 | 22 | 15 | 22·9 | 82·9° | 85° | 31·8* |
| „ 16–31 | 20 | 10 | 23·3 | 86·4° | 85° | |
| Nov. 1–15 | 17 | 6 | 24·2 | 86·0° | 83° | 41 1 |
| „ 16–30 | 25 | 16 | 25·9 | 81·5° | 80° | |
| Dec. 1–15 | 27 | 23 | 27·1 | 80·6° | 79° | 69·1 |
| „ 16–31 | 13 | 12 | 27·6 | 78·8° | 78° | |
| Jan. 1–15 | 20 | 16 | 27·6 | 79·0° | 78° | 77·7 |
| „ 16–31 | 31 | 28 | 29·1 | 78·0° | 77° | |
| Feb. 1–15 | 48 | 32 | 31·0 | 77·2° | 77° | 73·8 |
| „ 16–29 | 40 | 30 | 30·1 | 76·9° | 77° | |
| Mar. 1–15 | — | — | — | 78·8° | — | 62·5 |

* Approximate.

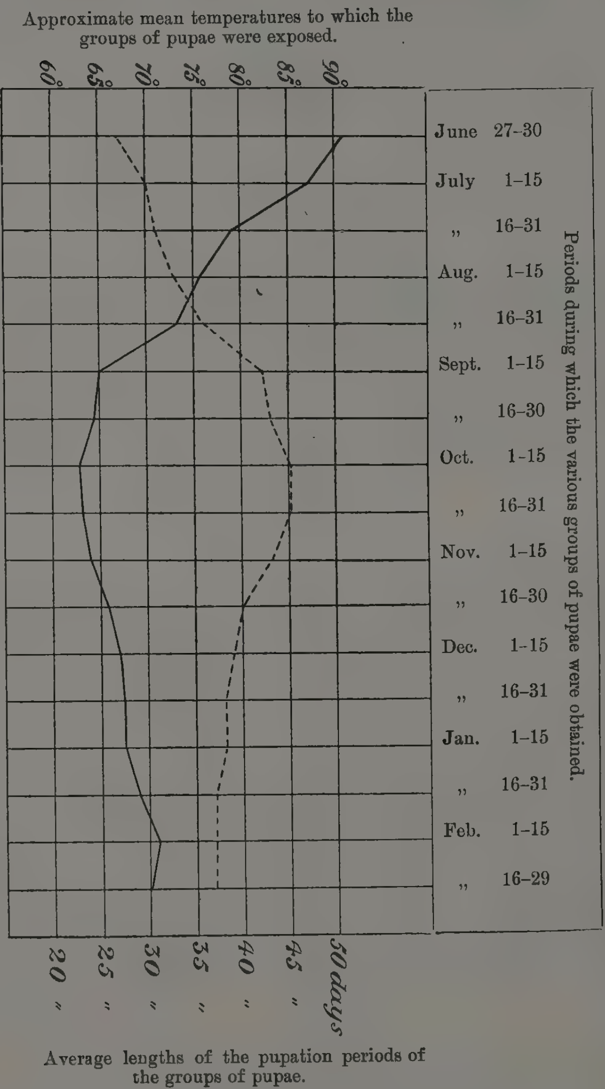


*Diagram illustrating the influence of temperature on the pupation period of* G. morsitans.

The pupation periods are represented by the continuous, the temperatures by the broken, line.

**Breeding.**

The hot dry season has had a very deleterious effect on the breeding of the flies, as shown not only by a reduction in the numbers of pupae produced, but also by the subsequent death of a large proportion of these. In the hotter months great difficulty was experienced in keeping the stock flies alive. Kinghorn* has already detailed the conditions under which the flies were kept and the method adopted, so that no more need be said under this head.

The full history of the pupae produced is given in the accompanying table. The number of abortions is not included as a full record of these was not kept. Abortions were most numerous during September and October, while in the cooler months there were not many. The number of stock flies was roughly constant, the small number of pupae obtained during September being due to the raid of ants mentioned above. Flies freshly caught do not breed so well as those which are accustomed to captivity. The mean temperature is that of the room in which the flies were kept. The readings of the wet and dry bulb thermometers were taken in the open air under shade. The approximate mean temperature to which the pupae were exposed has been arrived at by averaging the mean laboratory temperatures for the periods in which the pupae were obtained and those periods following which could have influenced them. The table shows that as the temperature rose from 67° to 85° the duration of the pupal life was reduced from fifty-one to twenty-three days, and the accompanying diagram will illustrate the ready response of the pupae to even slight changes of temperature. Without direct experiment it would be impossible to estimate the relative influence of temperature and humidity. Since however the humidity of the air to which the pupae of November 1–15 were exposed was greater than that during the pupation period of the October groups, it would appear to be the high temperature rather than the low relative humidity that caused the death of the pupae.

In conclusion I must express my indebtedness to Dr. Kinghorn, the Chief Investigator of this Commission, for the use of some of the data of the pupation periods, and for assistance in many ways.

*Ngoa, N. Rhodesia, May* 1912.

* Kinghorn, Bull. Ent. Res. II, p. 291.

# A KEY FOR DETERMINING THE AFRICAN SPECIES OF ANOPHELES (SENSU LATO).

By F. W. Edwards, B.A., F.E.S.

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The compilation of the following key has been a matter of no little difficulty, mainly owing to the close connection of the species in some of the groups, which sometimes makes it almost impossible to assign specific limits. The difficulty has in some cases been increased through the paucity of material, which prevents any adequate conception of the range of variability being obtained. This is particularly the case with some of the species coming from the Mediterranean region, which are very closely allied, and of which, as a rule, the British Museum possesses very few specimens. Names have only been sunk here as synonyms in those cases where there appeared to be no reasonable doubt, either after a comparison of the types, or of the descriptions, when these were sufficiently detailed. Eventually, therefore, it may be found that some forms which are here given specific rank will have to be regarded at most as varieties. Since so many figures of Anopheline wings, etc., have already appeared, it is not deemed necessary to add to their number. Some new records have been included, but on the other hand some old ones, which appeared to be questionable, have been omitted. As with the writer's previous papers, this key is merely intended to supplement the detailed descriptions which will be found in other works.

The recent subdivisions of the old genus, proposed by Mr. Theobald, have been discarded, since they grade imperceptibly into one another, and are not founded on any structural differences, while *Anopheles* in the broad sense is a very well-defined genus easily recognisable even by an amateur. It is sometimes argued that certain species are more and others less closely related, and that it is necessary to give expression to this obvious fact in our nomenclature, by the employment of a generic or subgeneric name for each group. But such a course appears to me to be quite unnecessary, and to tend merely to obscure larger relationships, while it greatly increases the difficulty of determination. In the proposed "genera" of Anophelines the characters relied upon are not only most trivial, but are sometimes variable within specific limits (*e.g.*, "*Pyretophorus*" *costalis*), and may be confined to one sex. It is quite possible, too, that genera founded on such superficial characters as the width of the scales might prove to be polyphyletic. The differences found in the larvae, like those between the adults, are very slight, and moreover they do not seem to support the classification by scale characters.

The leading characters of the key will serve to indicate the approximate limits of such of these so-called genera as are African, but as Lt.-Col. Alcock has shown us,* they cannot be clearly distinguished—except perhaps *Nyssorhynchus* [= *Cellia*] and *Christya*, both of which have well-marked lateral scale-tufts, but entirely different in character, while the latter has no scales on the

* Ann. Mag. Nat. Hist. (8) viii. 1911, pp. 240–247.

dorsal surface of the abdomen; I have seen no transition between species with abdominal scale-tufts and those without them. The divisions of *Anopheles* found in Africa to which generic names have been given are as follows:

| | | |
|---|---|---|
| *Anopheles*, Mg. | Type ... ... | *maculipennis*, Mg. |
| *Myzomyia*, Blanch. | " ... ... | *rossi*, Giles. |
| *Pyretophorus*, Blanch. | " ... ... | *costalis*, Lw. |
| *Feltinella*, Theo. | " ... ... | *pallidopalpi*, Theo. |
| *Myzorhynchus*, Blanch. | " ... ... | *sinensis*, Wied. |
| *Christya*, Theo. | " ... ... | *implexa*, Theo. |
| *Neocellia*, Theo. | " ... ... | *indica*, Theo. |
| *Nyssorhynchus*, Blanch. | " ... ... | *albimanus*, Wied. |
| *Cellia*, Theo. | " ... .. | *pharoensis*, Theo. |

*Feltinella* is indistinguishable from *Pyretophorus* and *Cellia* from *Nyssorhynchus*. The group called "*Nyssorhynchus*" in the fourth and fifth volume of Theobald's Monograph is really unnamed, since the type species of *Nyssorhynchus* has pronounced lateral scale-tufts.

### *Key to the African Species of* Anopheles.

1. Thorax with distinct broadish-elliptical scales (except in *A. christyi*); female palpi shaggily scaled; abdomen usually more or less scaly ... ... ... ... ... ... ... ... 2.
   Thorax clothed with hairs or narrow almost hair-like scales; scales of female palpi usually appressed; abdomen without scales on the dorsal surface ... ... ... ... ... 13.
2. Abdominal scales obviously present on all the segments ... ... 3.
   Abdominal scales absent, or if present, confined to the terminal segments ("*Nyssorhynchus*") ... ... ... ... ... 8.
3. Abdominal scales forming distinct projecting lateral tufts (*Nyssorhynchus*, [= *Cellia*]) ... ... ... ... ... ... 4.
   Abdominal scales not forming tufts (*Neocellia*) ... ... ... 9.
4. Last joint of hind tarsi light, or at least light-tipped ... ... 5.
   Last joint of all tarsi entirely dark ... ... ... ... ... 7.
5. Last joint of fore and mid tarsi all dark; rather large yellowish species (5–6 mm.)* ... ... ... ... ... ... *1. pharoensis.*
   Last joint of fore and mid tarsi light or light-tipped; smaller, less yellow species (4.5 mm. or less) ... ... ... ... ... 6.
6. Last joint of all tarsi wholly yellow; remaining joints regularly ringed with black and yellow; very small species (3 mm.) *2. cinctus.*
   Last joint of all tarsi white tipped; remaining joints not ringed; larger species ... ... ... ... ... ... *3. jacobi.*
7. Hind tarsi entirely dark ... ... ... ... *4. argenteolobatus.*
   First four joints of hind tarsi with apical white rings ... *5. squamosus.*
8. Last tarsal joint white; small species (3.5 mm.); Egyptian *6. maculicosta.*
   Last tarsal joint not white; large species (7 mm.); East African *7. christyi.*

* Unless otherwise stated, measurements denote the length of the body exclusive of the proboscis.

9. Hind tarsi entirely dark ; three white palpal bands in ♀, the first two narrow ... ... ... ... ... ... ... *8. brunnipes.*
Last two or three joints of hind tarsi white ... ... ... 10.
10. Four narrow white palpal bands ; wing-scales lanceolate ; legs spotted ... ... ... ... ... ... *9. aureosquamiger.*
Three palpal bands, the last two rather broad ; wing-scales much narrower ... ... ... ... ... ... ... ... 11.
11. Femora and tibiae white-spotted ... ... ... ... ... 12.
Femora and tibiae not white-spotted ... ... ... *10. rufipes.*
12. Palpi white-spotted ... ... ... ... ... *11. maculipalpis.*
Palpi not white-spotted ... ... ... ... *12. pretoriensis.*
13. Abdomen with lateral tufts of very long slender scales on each segment (*Christya*) ... ... ... ... ... *13. implexus.*
Abdomen without lateral scale-tufts ... ... ... ... 14.
14. Wing-scales mostly yellow, the black patches on the veins much reduced, but three long and one short black marks on the costa and first vein, the first two almost or quite united ... ... 15.
Wings not so marked ... ... ... ... ... ... 16.
15. Last $2\frac{3}{4}$ joints of hind tarsi white ... ... ... ... *14. theileri.*
Last joints of hind tarsi dark ... ... ... ... *15. wellcomei.*
16. Wings with at least three pale spots on the costal border (doubtful species are included in the next division) (*Myzomyia*) 17.
Wings with at most two pale spots on the costal border ... ... 36.
17. Last hind tarsal joints white ; legs spotted ... ... *16. natalensis.*
Last hind tarsal joints not white ... ... .. ... ... 18.
18. Femora and tibiae more or less spotted with whitish ; tarsi distinctly ringed at the joints ... ... ... ... ... 19.
Femora and tibiae not at all white-spotted... ... ... ... 20.
19. Hind metatarsi with about five well-marked narrow whitish rings ; female palpi with four narrow white rings ... *17. ardensis.*
Hind metatarsi without distinct rings ; female palpi with three white rings, the apical one broad ... ... ... ... *18. costalis.*
20. Third vein with three dark and two light areas ; male palpi with the club mainly yellow, as in *costalis* ... *19. pallidopalpi.*
Third vein with only two dark areas (near base and apex), or entirely dark ... ... ... ... ... ... ... 21.
21. Palpi of female white only at the apex ; base of first fork-cell nearer apex of wing than that of second ; small, very dark species ... ... ... ... ... ... ... *20. nili.*
Palpi of female with three or four white rings ... ... ... 22.
22. Third vein mainly (*funestus*, type form, and *culicifacies*) or entirely dark ; mesonotum clothed with hairs ... ... ... 23.
Third vein mainly pale ... ... ... ... ... ... 26.
23. Hind tarsi with fairly distinct pale rings : wing-field with some pale spots ... ... ... ... ... *21. longipalpis.*
Legs entirely dark ... ... ... ... ... ... ... 24.

24. Wing-field entirely dark; no pale scales even at bases of fork-cells ... ... ... ... ... ... ... *22. rhodesiensis.*
Pale spots present at bases of fork-cells, even in the darkest specimens 25.
25. Lighter species, Mediterranean and Oriental ... *23. culicifacies.*
Darker species (very variable), Ethiopian ... ... ... *24. funestus.*
26. Palpi of female black-tipped ... ... ... ... ... 27.
Palpi of female white-tipped (in *A. cinereus* the white scales at the tip are easily rubbed off); mesonotum with narrow but fairly distinct scales ... ... ... ... ... ... 30.
27. No dark scales on first fork-cell or on anterior branch of second *25. impunctus.*
Dark spots present (though sometimes small) on first fork-cell ... 28.
28. Vestiture of mesonotum consists of hairs ... ... ...*26. hispaniola.*
Vestiture of mesonotum consists of narrow scales ... ... ... 29.
29. Third and fourth costal spots smaller; first fork-cell mainly pale-scaled ... ... ... ... ... ... ... *27. chaudoyei.*
Third and fourth costal spots larger; first fork-cell mainly dark-scaled ... ... ... ... ... ... ...*28. multicolor.*
30. Last joint of female palpi mainly dark, pale at each end; large species, wing-length about 5 mm. ... ... ... ... *29. cinereus.*
Last joint of female palpi mainly or entirely white ... ... 31.
31. Tarsi dark; middle ring on female palpi rather narrow ... ... 32.
Tarsi with pale articulations... ... ... ... ... ... 33.
32. Average wing-length 3·8 mm. ... ... ... *30. transvaalensis.*
Average wing-length 3 mm.... ... ... ... ... *24. funestus.*
33. Larger (about 5 mm.); Mediterranean ... ... *31. superpictus.*
Smaller; Ethiopian; middle and terminal pale rings on female palpi about equal and rather broad; tarsal joints with narrow yellowish rings ... ... ... ... ... ... ... ... 34.
34. Larger, darker species (3·5–4·5 mm.); third and fourth costal spots larger ... ... ... ... ... ... ... *32. marshalli.*
Smaller, lighter species (3–3·2 mm.); third and fourth costal spots smaller ... ... ... ... ... ... ... ... 35.
35. A dark spot at apex of wing... ... ... ... ... *33. pitchfordi.*
No dark spot at apex of wing ... ... ... ... *34. flavicosta.*
36. Thorax clothed with narrow scales; light spots on wings more numerous ... ... ... ... ... ... ... ... 37.
Thorax clothed with hairs (excluding the scales near the front margin); wings very dark, or else quite unicolorous ... ... 39.
37. The two last palpal bands (in female) about equal and rather broad—as in *A. marshalli*; tarsal joints with rather broad white apical rings ... ... ... ... ... ... ... *35. austeni.*
Palpi of female with four narrow whitish rings; the terminal joint having a dark ring in the middle ... ... ... ... ... 38.
38. Numerous yellow forked scales on the head; legs dark, tarsi scarcely ringed ... ... ... ... ... ... *36. distinctus.*
No yellow forked scales on head; femora and tibiae spotted with whitish, tarsi distinctly ringed at the joints *18. costalis* var. *melas.*

39. Last 2–3 joints of hind tarsi white; female with a tuft of scales on the ventral side of the last abdominal segment (*Myzorhynchus*) ... *37. mauritianus.*
Last joints of hind tarsi not white; female without ventral scale-tuft ... ... ... ... ... ... ... ... ... 40.
40. Blackish species; wings with some pale spots ... ... ... 41.
Lighter species; wings without any pale spots ... ... ... 42.
41. Female palpi shaggily scaled: pale scales of wings occurring mainly on the fourth, fifth and sixth veins ... ... *38. umbrosus.*
Female palpi with appressed scales; pale scales of wings less numerous and occurring mainly on the first vein ... *39. smithii.*
42. Wings with dark spots formed by accumulation of scales *40. maculipennis.*
Wings without any dark spots ... ... ... ... ... 43.
43. First fork-cell longer than second ... ... ... *41. algeriensis.*
Fork-cells of equal length ... ... ... ... *42. antennatus.*

Unidentified species: *A. minuta*, Macq., Dipt., I, p. 33 (1834). The complete description is as follows: "3. A. NAIN.—*Anopheles minuta*, nob. Long. 2 lig. Gris. Palpes à anneaux blancs. Ailes à bord brun, et à trois petites taches blanchâtres. ♀. Du Sénégal. Muséum d'histoire naturelle à Paris." If the type is still in existence the species might be identifiable, but not otherwise.

1. **A. pharoensis,** Theo., Mon. Cul. I, p. 169 (1901).
*Cellia pharoensis*, Theo., Mon. Cul. III, p. 109 (1903).
*Nyssorhynchus bozasi*, N.-L., Arch. Parasit. X, p. 246 (1906).

Neveu-Lemaire gives good figures of this species.

Palestine; Egypt; Sudan; Gambia; N. and S. Nigeria; Togo; Belgian Congo; Angola; S. Rhodesia; Madagascar.

2. **A. cinctus,** Newst. and Cart. (*Cellia*), Ann. Trop. Med. IV, p. 381 (1910).
Ashanti.

3. **A. jacobi,** Hill and Haydon (*Cellia*), Ann. Natal Mus. I, p. 144 (1907).
Natal.

4. **A. argenteolobatus,** Gough (*Cellia*), Transvaal Dept. Agric., Rept. Gov. Vet. Bact. 1908–09, p. 116 (1910).
*Cellia pseudosquamosa*, Newst. and Cart., Ann. Trop. Med. V, p. 236 (1911).
Transvaal; N.E. Rhodesia.

5. **A. squamosus,** Theo., Mon. Cul. I, p. 167 (1901).
*Cellia squamosa*, Theo., Mon. Cul. III, p. 109 (1903).
*Cellia tananarivensis*, Ventr., Bull. Mus. Paris, XII, p. 198 (1906).
? *Cellia pretoriensis*, Gough (*nec* Theo.), Transvaal Dept. Agric., Rept. Gov. Vet. Bact. 1908–09, p. 117 (1910).

Egypt; Sudan; N. Nigeria; Sierra Leone; Gold Coast; Angola; Natal; Transvaal; S. Rhodesia; Nyasaland; British E. Africa; Madagascar.

I am unable to separate *C. pretoriensis* and *C. tananarivensis* from *A. squamosus* by comparing the descriptions, and consider them the same.

*Cellia squamosa*, var. *arnoldi*, Newst. and Cart., Ann. Trop. Med. V, p. 238 (1911), (*Cellia arnoldi*, Stph. and Chr., Prac. Stud. of Malaria, Ed. III, 1908,

p. 175). The fact that this differs from typical *A. squamosus* only in the absence of the white pleural lines, would certainly seem to justify sinking it under that species, yet it is hardly conceivable that larvae so different as those described by Hill and Haydon and Newstead and Carter could be conspecific. Possibly some confusion of adults has arisen. The character given for the separation of the adults seems quite inadequate.

6. **A. maculicosta,** Becker, Mitt. Zool. Mus. Berlin, II, p. 69 (1903).

Dr. Becker has kindly supplied me with the following additional notes on the type :—" *Thorax* grey, not brown. Pleurae and sternum light grey, with red-brown patches, not dark as in *pharoensis*. *Abdomen* : scales yellowish, no darker scales on side and at the end of the abdomen and no broad scales sticking outwards on the borders. *Femora* and *tibiae* are quite yellow brown with some little brown irregular patches, but not banded, the hind *tarsi* quite yellow-brown, their base somewhat darker, the ends of them and the last joint yellow, not white. *Wings* in general pictured like *A. pharoensis*. *Length* 3·5 mm., not 8 mm.

" After this I believe *A. maculicosta* is a species closely allied to *A. pharoensis*, but differs in the ornamentation of the pleurae and the legs and the length of the body." In spite of the differences indicated, I am inclined to think that *A. maculicosta* was described from a small rather worn specimen of *A. pharoensis*. The lateral projecting scales of the abdomen may well have been rubbed off, and as to size, I can only say that I have seen no specimen of *A. pharoensis* which exceeded 6 mm. in length, and that they are often a good deal less. *A. maculicosta* was described from Egypt, where *A. pharoensis* is common.

7. **A. christyi,** Newst. and Cart. (*Neocellia*), Ann. Trop. Med. V, p. 238 (1911).

A large mosquito resembling *A. mauritianus* in general appearance, but with more distinctly spotted wings and without white hind tarsi ; it is easily distinguished with a lens by its scaly abdomen, the scales not forming lateral tufts. The dark spots of the wings stain the membrane, so that even a denuded specimen would be easy to recognise.

Uganda ; British E. Africa (Njoro and Nairobi, *T. J. Anderson*).

8. **A. brunnipes,** Theo. (*Nyssorhynchus*), Mon. Cul. V, p. 64 (1910).

Angola.

9. **A. aureosquamiger,** Theo. (*Pyretophorus*), Mon. Cul. IV, p. 73 (March 18, 1907).

Hill and Haydon in their description of *A. natalensis* make no mention of the scales on the thorax. This may be only an omission, as there seem no other characters to separate *natalensis* and *aureosquamiger*.

Transvaal.

10. **A. rufipes,** Gough, Transvaal Dept. Agric., Rept. Gov. Vet. Bact. 1908–09, p. 119 (1910) (as var. of *Nyssorhynchus pretoriensis*).

*Anopheles* (*Nyssorhynchus*) *watsoni*, Edw., Bull. Ent. Res. II, p. 143 (1911), (nec *Pyretophorus watsonii*, Leicester, 1908).

This species seems rather variable in the amount of white on the hind legs. Specimens bred by Dr. Ingram at Bole, Gold Coast, have the white ring at the

apex of the hind metatarsus almost absent, and no dark ring at the base of the third hind tarsal joint. These specimens differ from the Oriental *A. fuliginosus* in having no scales on the abdomen of the female.

Transvaal; British E. Africa (Masongaleni, *S. A. Neave*); Gold Coast (Bole, *Dr. Ingram*); N. Nigeria; S. Nigeria (Oshogbo, *Dr. J. J. Simpson*).

11. **A. maculipalpis**, Giles, Gnats, Ed. 2, p. 297 (1902).
*Nyssorhynchus indiensis*, Theo., Mon. Cul. V, p. 62 (1910).

Transvaal; S. Rhodesia; Angola; Belgian Congo; N. Nigeria; Mauritius; India.

12. **A. pretoriensis**, Theo. (*Nyssorhynchus*), Mon. Cul. III, p. 99 (1903).
Transvaal; Natal.

13. **A. implexus**, Theo. (*Christya*), Royal Soc., Rept. Sleeping Sickness Com., III, p. 34 (1903).

A very striking species, one of the largest of the genus. The third and fourth joints of the hind tarsi are white, the fifth black. Femora and tibiae spotted.

Uganda; British C. Africa (?). The latter record is now omitted by Theobald.

14. **A. theileri**, nom. nov.
*Pyretophorus albipes*, Theo., U. South Afr. Dept. Agric., First Rept. Vet. Res. p. 243 (1911) (nec *A. albipes*, Theo., 1901).

A very distinct species, but in its wing-markings almost identical with the following.

Transvaal.

15. **A. wellcomei**, Theo., First Rept. Wellc. Lab. p. 64 (1904).
Sudan; N. Nigeria; Angola.

16. **A. natalensis**, Hill and Haydon (*Myzorhynchus*), Ann. Natal Mus. I, p. 152 (March 8, 1907).
Natal.

*A.* (*Pyretophorus*) *watsonii*, Leicester, from Malaya, answers rather closely to the description of this species, the only apparent distinctions being that in *A. watsonii* the wing-scales are shorter and less dense, and the three additional spots on the first longitudinal vein reach the costa.

17. **A. ardensis**, Theo. (*Pyretophorus*), J. Econ. Biol. I, p. 17 (1905).

This species, though superficially very like *A. costalis*, probably has its nearest ally in *A. natalensis*.

Natal.

18. **A. costalis**, Theo., Mon. Cul. I, p. 157 (1901).
? *A. costalis*, Lw., Berlin ent. Zeitschr. X, p. 55 (1866).
*A. merus*, Dönitz, Zeits. Hygiene, XLI, p. 77 (1902).
*A. gracilis*, Dönitz, *l.c.* p. 76.
*A. arabiensis*, Patton, J. Bombay Nat. Hist. Soc. p. 625 (1905).

Loew's original description includes no mention of the spots on the legs or of bands on the tarsi, hence it is most probable that Dönitz is correct in regarding Theobald's identification of *A. costalis* as erroneous. But without examination

of the type it would probably be impossible to determine which is the true *costalis*, and so in the absence of proof of its error, I have allowed the name *costalis* to stand for this species. I agree, however, with Dönitz that *A. costalis*, Lw., is very likely to prove the same as *A. cinereus*, Theo., or perhaps *A. transvaalensis*, Carter.

This species is in many respects a variable one, and is common throughout the Ethiopian region.

19. **A. pallidopalpi**, Theo. (*Feltinella*), Mon. Cul. IV, p. 57 (1907).
Sierra Leone.

The statement that in this species the "basal lobe of the genitalia" is "divided into two segments" is incorrect; the type specimen is merely broken.

20. **A. nili**, Theo. (*Myzomyia*), First Rept. Wellc. Lab. p. 65 (1904).
*Myzomyia funesta*, var. *umbrosa*, Theo., Mon. Cul. III, p. 34 (1903), (*nec Myzorhynchus umbrosus*, Theo.).
*Myzomyia unicolor*, Grünb., Zool. Anz. XXIX, p. 379 (1905).
*Anopheles* (*Myzomyia*) *umbrosa*, Edw., Bull. Ent. Res. II, p. 142 (1911).
Sudan; N. & S. Nigeria; Togo.

Both *M. funesta* var. *umbrosa* and *M. umbrosus* were described by Theobald in his third volume, but the latter is better known and so the name *A. umbrosus* is retained for it. The idea of page precedence is rejected as absurd.

21. **A. longipalpis**, Theo. (*Myzomyia*), Mon. Cul. III, p. 37 (1903).
Brit. E. Africa (Makindu, 3,300 feet, 6. iv. 1911, *S. A. Neave*, 1 ♀); Nyasaland (Blantyre, 1910, *Dr. J. E. S. Old*).

22. **A. rhodesiensis**, Theo. Mon. Cul. I, p. 184 (1901).
S. Rhodesia; Transvaal; Sierra Leone (?).

This species has been confused with the dark varieties of *A. funestus*, and not all the records of it can be trusted.

23. **A. culicifacies**, Giles, Ent. Mo. Mag. XXXVII, p. 197 (1901).
*Pyretophorus sergentii*, Theo., Mon. Cul. IV, p. 68 (1907).

This synonymy is given after a comparison of the type, and of a large series of specimens from India.

Algeria; India.

24. **A. funestus**, Giles, Liverp. S. Trop. Med. Mem. 2, p. 50 (1900).
*A. hebes*, Dönitz, Zeit. f. Hygiene, XLI, p. 84 (1902).

Widely distributed in the Ethiopian region, but much commoner in West Africa. Some of the varieties may be characterised as follows:—

(i) *A. funestus* (type form). A pale spot on the costa near the base; third vein pale-scaled in the middle, sometimes for as much as one-third of its length; fringe spots distinct.

Dönitz's *A. hebes*, from E. Africa, resembles this form, but the wings seem to be rather narrower and often quite half of the third vein is pale-scaled. Theobald refers to the palpi of *A. hebes* as "mainly white"; this is merely an error of translation from Dönitz's description.

(ii) var. *subumbrosa*, Theo., Mon. Cul. III, p. 34 (1903). No pale spot on costa near base; third vein with some pale scales in middle; fringe spots usually distinct. As far as I can see Theobald's *Myzomyia leptomeres* (Mon. Cul. III, p. 38) is identical with this variety.

(iii) var. *bisignata*, Grünb., Zool. Anz. XXIX, p. 378 (1905). No pale spot near base of costa; third vein, and sometimes also the fifth vein, entirely dark; fringe spots indistinct or absent. The darkest specimens of this variety approach *A. rhodesiensis*, but always have pale spots at the bases of the fork cells, and the female palpi are shorter than in the latter species.

25. **A. impunctus,** Dönitz, Zeit. f. Hygiene, XLI, p. 67 (1902).
Egypt.

26. **A. hispaniola,** Theo. (*Myzomyia*), Mon. Cul. III, p. 49 (1903).
*Pyretophorus myzomyfacies*, Theo., Mon. Cul. IV, p. 69 (1907).
Algeria; Spain.

27. **A. chaudoyei,** Theo. (*Pyretophorus*), Mon. Cul. III, p. 68 (1903).
*Pyretophorus nigrifasciatus*, Theo., Mon. Cul. IV, p. 65 (1907).
Algeria; Cyprus; India.

8. **A. multicolor,** Camboulin, C. R. Acad. Sci., CXXXV, p. 704 (1902).

I believe this species is correctly identified, but there is one strange statement in the original description, namely, that the wings have blue markings. I assume this merely refers to iridescence, which, however, is not visible in the specimens at my disposal. Patton's *A. azriki* from Aden must be very close to this, but has the wing-fringe entirely dark.

Suez; Cairo (*F. Willcocks*).

29. **A. cinereus,** Theo., Mon. Cul. I, p. 161 (1901).
*A.* (*Myzomyia*) *jehafi*, Patton, J. Bombay Nat. Hist. Soc. p. 630 (1905).
Aden; British E. Africa; S. Rhodesia; Transvaal; Natal; Cape.

30. **A. transvaalensis,** Carter (*Pyretophorus*), Entomologist, XLIII, p. 237 (1910).

This is, in part, the species referred to by Hill & Haydon as *Myzomyia funesta*, but from their descriptions it would seem that they also included *A. marshalli*, and perhaps *A. pitchfordi*, under the same specific name. How far these forms really represent distinct species must remain doubtful for the present.

British E. Africa; Transvaal; Natal.

31. **A. superpictus,** Grassi, Reale Accad. Linc. p. 78 (1900).

Theobald's record of this from Mashonaland probably refers to some other species (perhaps to *A. transvaalensis*); he does not repeat it in his last volume. *A. superpictus* seems to be distinguished from *A. nursei* (which also occurs in the Mediterranean region) only by the banded tarsi.

32. **A. marshalli,** Theo. (*Pyretophorus*), Mon. Cul. III, p. 77 (1903).
*Pyretophorus pseudocostalis*, Theo., Mon. Cul. V, p. 41 (1910).
Uganda; British E. Africa; Nyasaland; S. Rhodesia; Transvaal; Angola.

33. **A. pitchfordi,** Giles, Rev. Anoph. p. 34 (1904).
Zululand ; Angola ; Congo ; Uganda.

34. **A. flavicosta,** Edw., Bull. Ent. Res. II, p. 142 (1911).
N. Nigeria.

35. **A. austeni,** Theo. (*Pyretophorus*), Entomologist, XXXVIII, p. 102 (1905).
Angola.

36. **A. distinctus,** Newst. & Cart. (*Pyretophorus*), Ann. Trop, Med. V, p. 234 (1911).
N. E. Rhodesia.

37. **A. mauritianus,** Grandpré, Planter's Gaz. Press (1900).
*A. paludis*, Theo., Royal Soc., Rept. Malaria Com. p. 75 (July 6, 1900).

The tarsal character given by Theobald for separating *mauritianus* and *paludis* breaks down, and I feel sure there is really only one species. There is, however, a fairly constant difference between specimens from East and West Africa : in the former there is a *broad* white patch embracing the apex of the hind tibia and the base of the metatarsus, on the upper surface: in the latter, which may be known as var. *paludis*, the patch is very narrow and inconspicuous.

Widely distributed in Africa, but as a rule uncommon. In Nairobi, British East Africa, however, it appears to be the commonest *Anopheles*.

I have been unable to consult Grandpré's original description, and do not know whether his name has priority. It has been retained because the form with a black spot at the base of the 3rd hind tarsal joint is by far the commoner, both in East and West Africa.

38. **A. umbrosus,** Theo. (*Myzorhynchus*), Mon. Cul. III, p. 87 (1903).
*Myzorhynchus obscurus*, Grünb., Zool. Anz. XXIX, p. 380 (1905).
*Myzorhynchus strachani*, Theo., Mon. Cul. IV, p. 85 (1907).

S. Nigeria : Congo (Coquilhatville, 20. XI. 1910, 1 ♀, *Dr. A. Yale Massey*) : Kamerun ; Malay States.

39. **A. smithii,** Theo., Entomologist, XXXVIII, p. 101 (1905).
Sierra Leone.

40. **A. maculipennis,** Mg., Syst. Beschr. I, p. 11 (1818).
Algeria ; Tunis ; Europe ; N. America (?).

41. **A. algeriensis,** Theo., Ann. Inst. Pasteur, XVII, p. 2 (1903) ; id., Mon. Cul. III, p. 21.
Algeria.

It is possible that this species may prove to be identical with *A. bifurcatus*, L.

42. **A. antennatus,** Becker, Mitt. Zool. Mus. Berlin, II, p. 68 (1903).
Egypt.

I have been unable to examine this species.

# SOME OBSERVATIONS ON THE BIONOMICS AND BREEDING-PLACES OF ANOPHELES IN SAINT LUCIA, BRITISH WEST INDIES.

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(Plates VI.–IX.)

The following article has been written from notes of observations and experiments extending over nearly three years—April 1909 to December 1911. Its main object is an attempt to demonstrate that a true conception of the production of Anopheline mosquitos in a definite country or district can only be formed by a large amount of continual work throughout the seasons of the year. At the present time very numerous observations are still to be made before much generalising should be allowed concerning the breeding-grounds and bionomics of these insects.

I am here concerned with two closely allied species only, namely, *Anopheles* (*Nyssorhynchus*) *argyrotarsis* and *A.* (*Nyssorhynchus*) *albimanus*. These are well-known malaria-carriers, and I have found oöcysts and sporozoits in both of them. Wherever mention is made of Anophelines or larvae in this article, it must be understood to refer only to these two species, for my observations have been restricted entirely to them.

## Natural features of St. Lucia.

The work has been confined to St. Lucia, a West Indian island, situated 13° 50′ N. Lat. by 60° 58′ W. Long. On the windward side it is washed by the Atlantic Ocean, and on the leeward by the Caribbean Sea. Its greatest length is about 27 miles, and its maximum breadth 14 miles; it is estimated that it has a superficial area of 238 square miles.

The island is almost entirely of volcanic origin. It is very mountainous, chains of hills dividing it up into a number of small and large fertile valleys which are covered by alluvial soil. The highest of the hills rises 3,012 feet above sea-level, and they are all densely covered with forests, which occupy the greater portion of the island. Deep rocky ravines either carry the water direct to the coast, or numbers of them coming together form a small river which, increasing in size, courses through the valleys to the sea.

The two ends of the island are comparatively flat, and this is due to coral formation having been built up on sunken volcanic rocks. There are numerous lagoons of small size in different parts of the island.

The mean temperature of the island is about 78° Fahr.; during the cool season it may fall as low as 65°, but it averages about 72° at that time of the year. In the hot months it frequently rises to 90° Fahr. The temperature falls only a few degrees at nights. The appended Table I. (p. 266) shows the rainfall for the last 22 years, the average being about 93 inches per year.

## Developmental stages of A. argyrotarsis and A. albimanus.

*Adults.*—The very closely allied *Anopheles argyrotarsis* and *A. albimanus* are easily distinguished from each other by the last tarsal joint of the hind leg being almost entirely black in *A. albimanus*, while, except for the claws, it is white in *A. argyrotarsis*. This is the only characteristic by which they can be readily separated with the naked eye. Magnification shows one or two other differences, but these vary to some extent, and are often not easily observed in specimens which have been kept for any length of time.

*Larvae.*—There is a bewildering number of small variations in colour, markings, relative size of parts, and hairs of Anopheline larvae of the same species, so that it is advisable to mention some of these and the manner in which they are produced.

The larvae suffer from a number of diseases due to Protozoa (chiefly VORTICELLIDAE) and vegetable organisms such as diatoms, algae and fungi. If a larva has much growth of fungi or algae upon it, or Protozoa within or adherent to it, it will present an unhealthy appearance (fig. 1, *c*); its movements will be sluggish; its relative proportions lost; numbers of its hairs will be altered, or entirely lacking; if it survives (and the majority do not), a long period

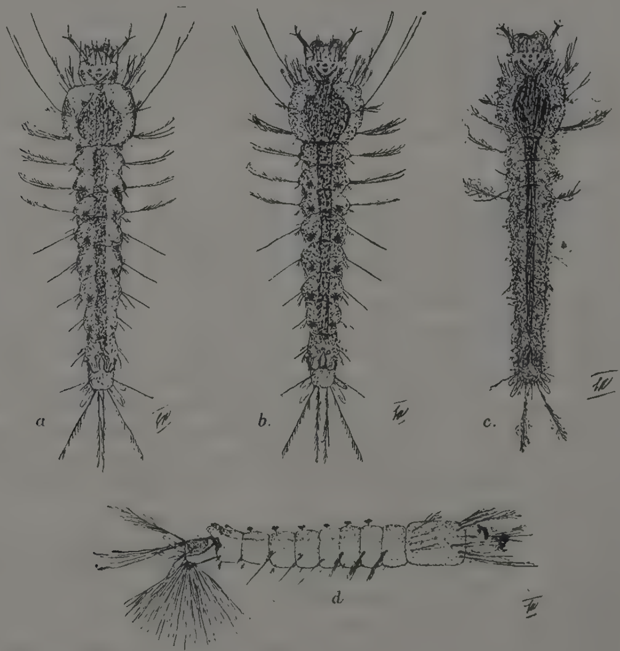


Fig. 1.—Larvae of *Anopheles* (*Nyssorhynchus*).

(*a*) *A. albimanus*, Wied., drawn from healthy larva of 6 mm.; (*b*) *A. argyrotarsis*, R.D., drawn from healthy larva of 6 mm.; (*c*) a diseased larva, 5 mm. in length, covered with algae and thousands of *Vorticellae*; (*d*) *A. argyrotarsis*, lateral view.

will be taken for its development.* On one occasion, from a large number of diseased *A. albimanus* I obtained two small stunted adults after 28 and 33 days respectively, their entire phases from egg to imagines had probably occupied nearly 40 days.

Again, the colour and observable markings vary according to the situation in which the larvae are found. Thus, in a muddy, light coloured, opaque pool, they will be a light brown; in a dark pool they will be nearly black; while among beneficent algae they may present a beautiful transparent, green-tinted appearance.

Further, the relative proportions of the body, depth of marking and colour, and length of hairs vary at different times and ages. Young larvae which have just moulted may be very difficult to see owing to their transparency, and at this time they are very susceptible to sunlight. The proportion of the head to the thorax is relatively larger in younger larvae; the hairs tend to protrude more before than after moults. It is therefore important, in giving a description of a single larva, to state the length of the specimen described and its probable stage of development.

The larvae of *A. argyrotarsis*, when 6 mm. in length, exhibit a maximum breadth of head a little more than one-half the maximum breadth of the thorax. The antennae are darker at their apices than at their bases (sometimes this is not well shown in very dark specimens), they are finely serrated on their inner sides and carry two small spines, between which is situated a short branched hair. There is a regular pattern on the dorsal surface of the head.

The plumose hairs which arise from small tubercles on the thorax do not reach far forward, but two pairs of long hairs reach well beyond the antennae (fig. 1, *a*, *b*).

The first three abdominal segments carry on each side a pair of feathered hairs, which curve forwards and arise from two tubercles situated one above the other. The remaining segments carry long straight hairs, pointing outwards and backwards, and these become progressively shorter from the fourth segment to the eighth; but the anal segment has a pair of hairs as long as those on the fourth segment. There are pairs of palmate hairs on the dorsum of the second to seventh segments inclusive, the function of these being to maintain the larva in a horizontal position on the surface of the water. The anal papillae are long and transparent, and show irregular curved lines upon them; the ventral brush springs from a crescent, and consists of a number of pairs of hairs (fig. 1, *d*).

The same description applies to *A. albimanus*, but healthy specimens of this species are easily differentiated by four pairs of brilliant white areas, situated on the front of the thorax and on the second, fifth, and eighth abdominal segments respectively (fig. 1, *a*). When feeding on algae the body usually assumes a transparent green appearance, and if these white areas are pronounced in such cases, the larvae are very beautiful objects. Unfortunately in many surroundings

* [Prof. G. S. West, of Birmingham University, has kindly examined some specimens sent home by Dr. Nicholls, which were covered with algae, and reports that "the mosquito larvae are covered with young plants of a sterile form of a species of *Oedogonium*. The zoospores must have come to rest on the larvae, attached themselves and then germinated. There are also many *Vorticellae*."—Ed.]

these marks grow indistinct, and may entirely disappear; in diseased specimens they are soon lost. At first this variability produced some chaos in my notes, in which I had attempted to keep separate records of the breeding-grounds of the two species; but as I found that the places they frequented were so similar, I have abandoned any attempt to discriminate between them.

*Pupae.*—The pupae of these species (fig. 2) have a pair of palmate hairs on the thorax which are similar to those situated on the dorsum of the segments of the larvae.


FIG. 2.—Pupa of *Anopheles albimanus*, Wied.; (*a*) lateral view, (*b*) dorsal view.

The trumpets have wide openings on their inner sides. The markings of the thorax vary greatly both in different specimens and at different stages of development.

Again, typical specimens of the pupae of *A. albimanus* can be distinguished by two large white blotches situated on the posterior part of the thorax (fig. 2, *b*).

## Length of life-cycle.

The egg hatches normally in 36 to 48 hours, but sometimes takes longer. It is extremely difficult to obtain eggs from captive females, and even then, they usually fail to hatch. I base the above length of time upon the following experiment:—A favourite Anopheline breeding-ground was chosen, just as it was drying up, and small pools were dug, and water added, which was taken from a source where no mosquitos could have had access to it. The pools were then protected with muslin, which was removed as it became dark. The next day, between 9 and 11 a.m., a thorough search was made for eggs, and in two of the pools a few were found; these pools were kept supplied with water to prevent them drying up, and muslin tents were placed over them. In 36 hours the larvae began to appear, and in less than 48 hours they were all hatched out.

In other experiments in which newly formed pools were tented within 12 hours of formation, I have had variable results. On one occasion it was indicated that *A. albimanus* might hatch out in 24 hours. Unfavourable circumstances can considerably prolong the egg-stage.

The length of the larval stage is very variable, and depends upon a number of circumstances, such as the nature of the food supply, the health of the larva, the protection from the elements, and the temperature of the water. Two of the larvae in the above experiment changed to pupae in 11 and 11½ days respectively from the date of hatching; but most of them pupated in between 12 and 14

days, the last pupa appearing on the fifteenth day. The surroundings were very favourable, and the experiment was made during the hot month of August.

A favourable artificial breeding-ground can be formed by cutting down a large tub to a depth of six inches. This is nearly filled with water, a little mud is stirred in, and a few grasses and algae added. It should be placed in a protected situation in the open, so that it gets the proper degree of shade and sunshine. Into such a receptacle small larvae, a little more than a millimetre long, were introduced, and in 85 cases the larval period exceeded 14 days only seven times. I have hatched out many hundreds of larvae in these six-inch tubs; but here I only include cases in which careful daily watching has shown that the food-supply has been more than adequate, and no disease has crept in. Disease always develops in artificial breeding-grounds, unless the water is properly changed, and the grasses or algae are obtained from fresh healthy situations. In glass vessels and in any adverse situations the larval period is greatly prolonged. I have kept an infected larva 31 days before it became a pupa, but the imago appeared in another two days.

I have on seven occasions seen a larva change to the pupal condition, and the same pupa hatch to an imago. The periods ranged from 47 hours 10 minutes to 54 hours 35 minutes. The statement is frequently made that the imago emerges from the pupa during the late afternoon. This is not so with *A. argyrotarsis* or *A. albimanus*, for as many emerge before noon as after this time.

It is very important that the duration of the developmental stages of mosquitos should be known, but obviously these cannot be stated to a day.

The following table gives the probable durations in days for *A. argyrotarsis* and *albimanus*:—

| —— | Under favourable conditions. | Maximum under unfavourable conditions. |
|---|---|---|
| Egg stage ... ... ... | $1\frac{1}{2}$–2 | $2\frac{1}{2}$ ? |
| Larval period ... ... | 11–14 | 31 or more |
| Pupal period ... ... | 2 | $2\frac{1}{2}$ ? |
| | $14\frac{1}{2}$–18 | 36 or more |

The food of the larvae consists of small particles of decomposing vegetable matter and minute water-plants; they are also able to devour the larvae of other Diptera, and will eat the decomposing bodies of all kinds of insects.

The length of life of the imago is very difficult to determine; but probably there are very few individuals which exist for more than six weeks. A fortnight is the average length of life in moderate-sized cages, with an abundant food-supply. This does not include the males, which rarely live for a week.

I once fitted up a room as a large cage. It was well cleared of spiders and other insects. A continuous supply of fruit was kept in it for food, and every second day I entered the room and allowed myself to be bitten. About 30 *A. albimanus* were hatched out and placed in the room. The last of them was alive on the thirty-first day, but none could be found on the thirty-fourth. Between these days I had been unable to enter the cage.

**General bionomics.**

*A. argyrotarsis* and *albimanus* appear to depend for their continued existence, in any but very small numbers, upon their adaptability for being the first insects to employ newly-formed pools for breeding purposes. In these, at first, they have little or no struggle for existence, for an abundant food supply is present, and natural enemies are absent; soon, however, Neuroptera, Coleoptera, and other creatures appear. As the pools become more crowded and stagnant, larval diseases become rife. In permanent situations these adverse conditions are usually present, the greatest destroyers of mosquito larva being small fish.

The following is an example of conditions changing in a pool. A small marshy swamp was formed in August 1911, and I examined 57 of the first larvae to appear; they were all healthy, and continuous search showed the absence of natural enemies. In September the larvae were less in numbers, and a percentage showed attacks of *Vorticellae* and algae; dragon-fly larvae had also appeared. Owing to continuous rains the pool was still present in November and December. The larvae were then far fewer; all were diseased, and numerous natural enemies were present. By the use of muslin tents covering 20 square feet, it was found that the rate of emergence in September was 16 adults for 24 hours. During November and December between two and three was the average for a similar time and area.

An equal number of *Stegomyia* and *Anopheles* larvae have been placed in pools containing natural enemies, in the form of "Millions" fish and dragon-fly larvae. In 36 hours all the former larvae usually disappear, their active wriggling movements quickly revealing them to the eyes of their enemies; about half the *Anopheles* larvae will remain, their less obtrusive position on the surface of the water preventing other creatures from readily observing them.

My conclusions are that the struggle against predaceous enemies is most severe in—(1) permanent situations containing fish; less severe in, (2) permanent situations containing Neuroptera and predaceous creatures other than fish; and practically non-existent in, (3) non-permanent situations which have lasted for not more than six weeks.

On the other hand, the struggle against disease, caused by protozoa and algae, is greatest in—(1) non-permanent areas of stagnant water, which are not spreading further afield, and which have lasted for over ten weeks; less in, (2) permanent pools of stagnant water; and absent in, (3) other permanent situations.

Therefore, from the point of view of their natural struggle for existence, recently formed non-permanent situations are indicated as the most favourable breeding-grounds for *Anopheles*.

The imagines are unobtrusive and purely nocturnal mosquitos, and bite all through the night. On one occasion a friend and myself sat at night in a small room in the neighbourhood of swamps carefully watching for *Anopheles*, and, as they were seen, they were caught in nets. Females started coming in at 7 p.m., but appeared in greater numbers after 10 p.m., and continued as numerous until 2 a.m., when we ceased observations.

During the day the females can be found resting in their characteristic, nearly-perpendicular attitude in any dark corners, or dotted over the walls of labourers' huts, which are usually kept well shut up.

There seems reason to believe that, in selecting a suitable situation for depositing her eggs, the female *Anopheles* will be influenced by the presence of food and shelter; and it is possible that the emanations of decomposing vegetable matter may perhaps be an attraction.

The following experiments support these suggestions:—

(A.) A shallow wooden vessel was placed among a number of pools which contained decomposing and suspended matter, the water in the vessel being quite clean and clear. The surrounding pools produced numerous larvae, but none appeared in the vessel.

(B.) Two similar tubs were exposed six yards apart; one contained a little bran and meal stirred into the water, the other had absolutely clean water. In a few days numerous *Stegomyia* larvae appeared in the former, while far fewer appeared in the latter. The bran and meal had undoubtedly attracted the gravid females.

The size of the pool is of some importance; large sheets of water are eschewed, but pools of moderate size are preferred to very small ones. Thus, in a piece of well-protected ground there were two freshly formed pools about four feet square and numerous small puddles about six inches to one foot across; larvae were numerous in the two larger, but were never present in the smaller pools. This is one of many similar observations, and exceptions are few.

Naturally, in dry weather, the female must find some place in which to deposit her eggs, and then they are laid in a number of less favourable situations, such as the edges of streams and rivers, in overgrown garden tanks and permanent pools, where they have little chance of becoming imagines. Again, on other occasions, a few larvae are likely to be found in these unusual situations, because there has been a vast production of mosquitos in the neighbourhood, and a few stray females will lay their eggs in these places. Thus, in certain marsh-land in 122 searches, I have found larvae on 86 occasions, but only twice at the edges of a neighbouring stream, and both occasions were after a favourable period which had produced myriads in the marsh.

The adult Anophelines have a struggle in life, though probably less severe than that of the larvae; anyhow, the struggle is less apparent, but the elements and their natural enemies must destroy a large number. Being very delicate insects, wind and torrential rain are very adverse to them, and, immediately after rough weather, few, if any of them, can be found. They are preyed upon by spiders of all kinds; often a pool is found which contains larvae, and so great is the network of spider-webs above the pool, that it is difficult to understand how the emerging mosquito can escape becoming entangled. This is especially the case in the more permanent pools in dry weather. Lizards, small frogs and dragon-flies also undoubtedly devour a considerable number of mosquitos.

The female Anophelines fly no further than the nearest blood-supply. This is well shown by the following observations:—

(A.) A certain village is situated in a narrow valley; on one side is the sea coast and behind it is a swamp. In the houses nearest the swamp large numbers of *A. albimanus* are often found, but rarely can they be obtained from the dwellings nearer the coast, and only 150 yards away.

(B.) A certain group of barracks, less than 200 yards across, has a small swamp located about 100 yards away on the south side. The men dwelling in the barracks on this side are extremely liable to malaria, which is uncommon among those on the north side.

There are several other instances of a similar kind in this island.

About 150 yards is the furthest I have had to search for a breeding-ground from a place in which I have found the adult Anopheline. I have known of primary malarial infection taking place at a greater distance than this, but the probability was that recent dry weather had obliterated the true place where the infecting mosquito was bred. A determined search often brings to light breeding-grounds nearer than is at first expected. On the other hand, I have made notes as to the distances at which Anopheline larvae have been found from the nearest human habitation, the greatest recorded distance being from 400 to 500 yards. But St. Lucia is, perhaps, too small and too densely populated an island to yield reliable observations of this kind.

There are reasons for believing that the few mosquitos which are blown some distance by the wind are almost a negligible factor in malarial infections.

In some countries, under different conditions and with other species, it is possible that flights of a considerable distance are made; especially would this be so where the inhabitants are a long way from the mosquito breeding-grounds; but this is never the case in this island with the species under consideration. The greater distance that a female Anopheline has to fly in search of blood, the greater must be the odds against her long survival.

## Methods for ascertaining the distribution of the larvae.

When I first started to hunt for larvae I was accustomed to examine the pools principally by a definite number of "dips" with a tumbler. It soon became apparent that this alone does not allow a sufficiently close study. As soon as a pool is disturbed, Anopheline larvae usually go to the bottom and often remain there for more than a minute; the consequence is they may not be immediately obtained in the dipper. Again, many thousands of larvae may be distributed over an area of swampy overgrown meadow-land and but a few be present in a small road-side pool; dipping will quickly reveal the latter, whereas the former will not be easily obtained, and the relatively unimportant pool may receive more attention than is paid to a piece of water-logged land which is giving rise every day to hundreds of mosquitos.

The following is the procedure which I have adopted for the last eighteen months; it has been of much value in throwing light upon many obscure points:—

(1) The pool is first thoroughly and closely inspected, especially at the edges and around suspended matter; if many larvae are present, one experienced in hunting for them will usually soon see them. They are especially apparent in freshly-formed opaque muddy pools which are favourite breeding-grounds, but in other situations, such as marshy land, a true conception of their numbers is not easily formed. A number of dips should now be made.

(2) The pool or swamp, or a definite portion of it, is cleared of floating matter and other débris; grasses and other vegetation are cut away below the surface

so as to leave nothing to obscure the water; in a few minutes the larvae will be seen returning to the surface, there is now a good chance of forming a conception of their numbers.

(3) The colour of the larvae varies with the nature of the situation in which they are found; ranging from a very light semi-transparent colour to nearly black; stirring up the mud at the bottom of the pool or adding a little chalky water will often show them up very distinctly.

(4) After much of the suspended material has settled, a net made of book-muslin may be swept in all directions over the pool; when turned inside out into a shallow dish the larvae taken will wriggle free into the water.

This net, or a net made of mosquito netting, is now employed for thoroughly searching the pool for other denizens, such as small fish, dragon-fly larvae, crustaceans, etc.

(5) Notes are now taken, showing the position and nature of the pool, elevation above sea-level, etc. The following are examples taken from my notebook:—

(*a*) March 16th, 1911. Small pool at the edge of Marchand River, about 100 yards from the cemetery, apparently caused by the receding level of the river, due to a few days' dry weather. Pool about one yard square; it contains algae, and small vegetation overhangs it; the bottom is sandy; considerable shade is derived from neighbouring mango trees. Fourteen larvae, no pupae counted; also contains several small fresh-water shrimps, and very small dragon-fly larvae.

March 20th. Most of larvae have disappeared. They could not have hatched out in this time.

(*b*) August 21st, 1911. Pool in continuity of road-side gutter, Cul-de-Sac road, elevation 640 feet above sea-level, average gradient of gutter about 1 in 20. Most of the water ceases to pass along the gutter, consequently it requires much rain to wash out the pools formed in it. There was considerable vegetation growing in and around the pool, which is also full of recently cut "bush." Larvae numerous.

(6) For the purpose of forming an approximate conception of the larvae which eventually become imagines in various situations, types of all forms of breeding-grounds must be screened with a muslin tent (Pl. IX, fig. 2). The method is to count as nearly as possible the number of larvae or pupae present in a definite area (usually six feet by four feet). The screen is placed over this area and the mosquitos which hatch out are counted. Again a definite number of larvae can be introduced into various places and the number of ultimate survivors noted.

Great care must be employed in setting the net; it should be well weighted down all round, or if it only includes a portion of the water, the edges of the net must be submerged. On several occasions I have found Attid spiders in the net, which had succeeded in crawling in under the free edge. Their presence makes the results valueless, for they will soon devour a number of mosquitos.

It is remarkable how few mosquitos succeed in breeding out from certain types of ground, whereas in others the struggle for existence is at times very small.

## Classification of breeding-grounds.

The collections of water which have to be studied for the purposes of a mosquito survey may be conveniently divided into four classes :—

(1) Non-permanent, (2) altered permanent, (3) permanent, and (4) miscellaneous.

### I. *Non-permanent waters.*

Under this heading I include those collections of water which are formed after heavy or continuous rainfall ; they can be further sub-divided into :—

(A.) Marshy land, which tends to become water-logged, but the water quickly disappears after a few dry days, though some deeper pools may remain. This land is the greatest producer of Anophelines in this island (Pl. VI, fig. 1). It will be found that bush and hills, or other objects, afford protection in each case. An illustration is given (Pl. VI, fig. 2) of a pasture land which is low-lying and situated in open country on the outskirts of a village ; though it frequently becomes water-logged and contains numerous pools, larvae have never been found in forty-seven searches in the more open parts. It will be seen therefore that these marshy places must afford some protection for the adults and larvae before mosquitos can thrive in them ; and while these insects may be entirely absent from the exposed portions of such localities, yet a careful investigation of obscure corners and sheltered nooks may reveal their presence in some numbers.

The following is an exaggerated example of this type of ground :—

It was a four-acre, water-logged, neglected cemetery, much overgrown with grass and bush, and with numerous high trees, the whole being surrounded by a high wall. The place had never been drained, except by a few gutters which were blocked up and overgrown. Around all the tumuli were depressions from which the earth had been obtained for the purpose of forming them ; apart from this the ground was naturally very uneven. During and just after rainy weather Anophelines were bred out from this ground in vast numbers, and malaria was rampant in the immediate neighbourhood.

(B.) Small pools. These may be small isolated pools partly overgrown by vegetation, or muddy hollows in protected situations, but without immediate protection from the elements. The former are common along road-side gutters, the latter are frequently formed by man in his agricultural or building work. I have known a herd of pigs to produce a large number of such holes when wallowing in soft mud in wet weather. One of these which contained numerous larvae is illustrated (Pl. VII, fig. 2). It was filled with opaque water, due to much suspended mud and decomposing matter, and the larvae lying on the surface were very apparent.

(C.) Large surface undulations. The water which collects in such situations tends to last a very short time in this island, and is relatively unimportant.

### II. *Altered permanent waters.*

Numerous waters are unsuitable for Anophelines until they are temporarily altered by the agency of the elements or man ; they may be subdivided into :—

(A.) Pools altered by heavy rains. In a number of pools I have been unable to find larvae except after heavy rains. The water has poured through

them and washed them out, but at the same time it has carried to them obstructing sticks and uprooted weeds. Besides, the water pouring off the land contains much suspended organic matter, such as the decomposing bodies of insects and a variety of vegetable substances, upon which larvae can flourish.

The water in the pools is always opaque during the rains and it requires the cessation of rain for about forty-eight hours before the pools become clear. This opacity, best promoted by continuous light rains, represents a source of food and protects the larvae from their natural enemies which may be lurking in the pools.

One of these pools, situated in the course of a ditch along a hill-side road is shown on Plate VII. (fig. 1).

(B.) Spreading pools. Rains will cause a pool to spread over the surrounding area, and although few if any larvae could exist in the pool itself, the newly formed portion, protected by floating matter and the surrounding vegetation, will frequently contain numerous larvae.

(C.) Obstructed waters. These may be caused by man and his domestic animals or by the agencies of nature.

A typical example of this caused by man is shown on Plate VI (fig. 1). A piece of marshy land, through which ran several shallow permanent ditches, was being drained. For eighteen months previously I had every week carefully examined this swamp, and Anopheline larvae were always found in numbers, after the rains, all over the marshy land, but very few were present in the ditches. It was decided to level the marshy land, and as this was being done the bush which was cut down was allowed to fall into the ditches, and temporarily filled them up with obstructions and decomposing matter, upon which algae quickly grew. Though there were at the time many fish and dragon-fly larvae in the ditches, they could not compete with the sudden great increase in the food-supply thus brought about, so that Anopheline larvae soon became present in extraordinary numbers, and this was followed by a noticeable increase in the number of cases of malaria. The photograph shows on the right-hand side the bush which was obstructing a gutter. The small area of clear water contained no larvae, but they were very numerous around it and anywhere where there was protection.

Cattle often trample down the edges of gutters and pools, causing small isolated, muddy and obstructed puddles, which are suitable for *Anopheles*; but this does not refer to such small puddles as those formed by the impression of a hoof.

Again the rains carry down much wood, bushes and uprooted vegetation, which may fill up pools and turn them into favourable breeding-grounds: or gutters and edges of canals may become overgrown with vegetation which protects the larvae from their natural enemies and the elements.

(D.) Backwaters and pools of rivers, ravines or streams. These are of importance because, in dry weather, larvae can usually be found in such situations, when an extended search will reveal few if any other breeding-grounds. They are formed by the shrinkage of the main watercourse, which may also leave a number of small isolated pools in protected situations. Again, dry weather causes small areas to become overgrown or obstructed from the main stream.

### III. *Permanent Waters.*

In these places larvae are occasionally found, usually in small numbers, and the struggle for existence is such that relatively few become imagines.

(A.) Edges of rivers and streams. The adaptability of these as breeding-grounds depends upon the rate of the current and the amount of overgrowing vegetation. Plate VIII, fig. 1, shows a swiftly running river which arises from the hills seen in the background; note the ripple of the strong current. Though the edges are somewhat overgrown, I have never found larvae in searches on 45 occasions. Near its mouth the stream becomes sluggish, and here by its overgrown banks (Plate VIII, fig. 2) larvae were found five times in twelve searches during dry weather; but when, in wet weather, the river is rising and falling many feet in a few days, no larvae can be found. A back-water of the same river (Plate IX, fig. 1), which is never much overgrown, is a favourite feeding-ground for shoals of small fish. I have never found larvae here (34 searches).

(B.) Edges of lagoons. Three lagoons have been under continuous observation. Two of them team with "millions" fish, and larvae have never been found (45 and 32 searches respectively). In back-waters connected with the third they have been found on 17 occasions in 112 searches, though the lagoon itself is full of a variety of fish and other natural enemies.

(C.) Artificial concrete garden-tanks, rain-tanks or "taches," which always contain water and are used for irrigation or agricultural purposes. When these become overgrown or covered with algae they may contain numerous Anopheline larvae. The number of these will vary with the nature of the surroundings; thus, if numerous Anophelines are produced in the immediate neighbourhood, many larvae may be found; the reverse is the case where there are few surrounding breeding-grounds. These tanks support numbers of dragon-fly larvae and consequently few Anophelines hatch out, as they and other mosquito larvae furnish the chief food of these creatures in these circumstances. This is demonstrated by the following experiment.

To a tache containing six Anopheline larvae, which appeared well protected by algae, 50 more larvae were added and the tache "tented" with muslin; only two mosquitos hatched out. Other experiments produced an average of 4·4 per cent. adults.

### IV. *Miscellaneous Collections of Water.*

From all of these *Anopheles* larvae are normally absent.

(A.) In water-receptacles around houses, such as tanks, calabashes, tins, broken crockery, shells of coconuts, etc., I have never found either *A. argyrotarsis* or *A. albimanus*. I have records of examinations of over a thousand of these water-receptacles, which are the principal breeding-places for the larvae of *Stegomyia* and other mosquitos.

(B.) Natural collections of water in wild pines, plantains, tannias, and holes formed in the decaying trunks of trees, are situations in which *Anopheles* are never found.

(C.) In the examination of numerous crab-holes, which usually teem with *Deinocerites cancer*, I have but once found an Anopheline larva, a single specimen of *A. albimanus.*

(D.) In the centres of lagoons, ponds, and running streams, I have never found them, though searches have been conducted from boats. In this island these situations contain very numerous fish.

(E.) Pools in barren rocks through which a stream continually but slowly runs. The temperature of these becomes very high as they are exposed to the direct rays of the sun, and there is very little food for larvae. I have never found Anophelines in such places.

*Summary of Breeding Places.*

1. *Non-permanent.*—These produce more Anophelines than all the other places put together, and in this island, and probably throughout the West Indies, they are the principal cause of malaria.

2. *Altered permanent.*—Produce far less Anophelines than the permanent, but are often more apparent, and more easily studied.

3. *Permanent.*—More apparent than 1 and 2, but relatively unimportant.

4. *Miscellaneous.*—Anophelines do not breed in these situations, though an occasional exception may occur.

## The Effect of Rainfall upon the Numbers of Anophelines.

It is not so much the amount as the nature of the rainfall that tends to promote the breeding of Anophelines. The amount of rainfall varies greatly in different localities in St. Lucia (Table II); thus in the year 1909, the least rainfall recorded was 61·23 in., and the greatest was 124·14 in. The latter amount fell in the densely clad forest heights, and the former on a small stretch of open country near the sea-shore; these two points are separated from each other only by about ten miles. The average rainfall from fifteen gauges situated in different parts of the island was for this year 86·6.

Provided over 60 inches of rain falls, the nature of the locality is of more importance than the yearly amount of rain. Thus two localities having a rainfall of 62·97 and 95·65 inches respectively are notoriously malarious, whereas two other places with 61·23 and 97·01 inches are almost free from malaria.

Most of the dense forest heights are free from Anophelines, for the continuous rainfall tends incessantly to wash out the hill-side pools; the temperature also is low, and the giant vegetation screens the pools from sunlight.

The rainfall for March 1909 (Table III, col. i) is typical for a month in the dry season; all the the non-permanent pools quickly dry up, and many permanent ones become very low and stagnant. Very few Anopheline larvae can be obtained in months of this kind.

October 1909, was a typical month of the wet season (Table III, col. ii); the rainfall, however, in some parts of the island was too uneven to be very favourable for Anophelines. Thus the period of dry weather recorded in

column ii, C., between 7th and 13th of this month, was sufficient to dry up numerous non-permanent breeding-grounds which were under observation in this locality.

May 1910 (Table III, col. iv, A. B. C.) was a month of extraordinary rainfall, and torrential rain is unfavourable to mosquito development. The roadside gutters, ravines, and rivers became swirling torrents, which repeatedly poured over and swept clean the low-lying marsh-lands. From the nature of the case, many common breeding-grounds could be excluded, and frequent searches over the large water-logged areas, when there were slight abatements in the rainfall, usually failed to reveal larvae of any description. During this and the following month, which had a nearly similar rainfall, I made searches in various quarters on 23 days and only on four days did I discover Anopheline larvae. On three of these occasions they were in small pools near habitations, and effectively protected by a wall or growth of vegetation from the general rush of water; in the other case, they were found on meadow-land, which was thoroughly overgrown with "guava bush." Probably the adult mosquitos also were destroyed in large numbers by the inclement weather.

February 1911 (Table III, col. v) was another unfavourable month. After the 10th, numerous pools and swampy, water-logged marsh-lands were found to be teeming with larvae, but the sudden drought dried these up so that few adults appeared.

The greater part of the year 1911 was very favourable to Anophelines, there being several months with an even and continuous rainfall. The month of November is typical (Table III, col. iii): rain fell, but seldom torrentially, on every day in some localities (col. iii, A). At the beginning of this month numerous places were already water-logged, and many Anophelines had appeared. Observations showed a great increase in Anophelines and their larvae, and the dispensary registers recorded an increase in the number of cases of malaria during the next month.

A still more favourable period occurred after May 1909. Dry weather had obliterated the majority of the breeding-grounds, and was followed by two evenly wet months, which produced great numbers of Anophelines, for the newly formed pools were free from their natural enemies and diseases. (Table III, col. vi).

## Conclusion.

It is possible to form generalisations on the breeding-places of the Anophelines of a definite country or locality, but at the present time it is inadvisable to do so, as our knowledge concerning their life-struggle and bionomics is still far from perfect.

All efforts directed to mosquito reduction should be founded, not on generalisations which show theoretically where the insects ought to breed, but upon knowledge of their breeding-grounds which has been obtained by a prolonged and thorough study of all collections of water which are formed during the year.

Probably there are numerous factors which apply to all countries and to all species of Anophelines ; but on the other hand, many important points may be found to be modified in different localities and for different species.

The necessity for carrying out examinations throughout the year has here been amply indicated. For instance, there are many places in this island which are the real sources of the malaria in the neighbourhood, but unless they are visited after continuous rains have water-logged them, their true importance cannot be appreciated.

The majority of visits would be fruitful in showing larvae to be present in certain overgrown streams, gutters or pools, and money might be spent in "canalising" or filling up these with little or no reduction of the malaria, as the occurrence of the disease actually depends upon myriads of mosquitos being occasionally bred out on water-logged and protected marsh-land ; and this fact might only come to light after repeated visits. All places which breed Anophelines should receive attention, but this should be directed according to the relative importance of the breeding-grounds.

The following are instances of what may occur from the lack of adequate investigation.

In one case it was intended to employ a large amount of kerosine oil on lagoons in malarial neighbourhoods. These lagoons, however, never breed mosquitos and are teeming with fish, whereas in the surrounding swampy pastures, which it is impossible to oil, larvae are numerous ; though they are slightly kept in check by the fish which are carried from the lagoons after heavy rains. The result of oiling might have been disastrous, if it had killed out the fish and other natural enemies ; in any case it could have been of no value. Kerosine oil is undoubtedly of great value for tanks and butts, but as an Anopheline larvicide, its use should be considerably restricted, as much damage may be done. In this island there are few, if any, situations where its use could be advised.

In the second case a road-side gutter was found to contain larvae at certain times, but as there was a small stream continually passing through it and it was on a hill-side, the larvae were frequently washed away, and could never develope if the gutters were kept clean. The gutter was filled up and the stream was carried away by culverts, with the unfortunate result that the water was directed to a piece of land which became water-logged, and thus one breeding place was merely replaced by another of a worse type.

## Table I.

*Monthly Rain-fall in St. Lucia for the last 22 years.*

| — | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | 1910. | 1911. | Average for 22 years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 1 6 | 3·9 | 7·3 | 4·5 | 6·0 | 11·1 | 5·5 | 3·8 | 4·6 | 6·4 | 2·4 | 4·6 | 2·5 | 4·0 | 8·5 | 2·9 | 3·3 | 3·6 | 2·2 | 4·5 | 5·6 | 8·7 | 5·30 |
| February . | 4·8 | 5·0 | 2·6 | 6·4 | 4·1 | 2·0 | 2·9 | 4·4 | 3·0 | 3·5 | 2·9 | 1·0 | 1·4 | 4·2 | 4·8 | 1·7 | 1·9 | 2·4 | 2·5 | 4·2 | 3·8 | 16·6 | 3·92 |
| March ... | 3·8 | 1·2 | 5·0 | 3·1 | 5·8 | 6·4 | 6·8 | 5·8 | 4·4 | 5·1 | 3·1 | 2·1 | 2·1 | 3·3 | 3·5 | 5·3 | 2·4 | 2·9 | 2·5 | 2·2 | 5·3 | 5·9 | 4·46 |
| April ... | 4·2 | 1·9 | 4·0 | 9·6 | 2·8 | 4·3 | 13·0 | 1·8 | 5·2 | 1·3 | 2·8 | 1·0 | 1·9 | 3·3 | 2·0 | 3·0 | 2·0 | 2·2 | 5·7 | 4·5 | 3·4 | 7·9 | 4·01 |
| May ... | 4·0 | 4·3 | 14·8 | 9·0 | 2·7 | 14·5 | 12·0 | 18·9 | 2·4 | 1·3 | 7·3 | 4·7 | 9·2 | 2·3 | 6·3 | 5·2 | 5·1 | 4·2 | 3·8 | 4·4 | 21·9 | 13·0 | 8·26 |
| June ... | 6·5 | 6·2 | 20·1 | 10·6 | 7·7 | 4·6 | 14·3 | 8·9 | 6·7 | 8·7 | 6·2 | 9·2 | 2·3 | 6·3 | 5·2 | 5·1 | 4·2 | 8·7 | 5·8 | 10·20 | 15·1 | 9·1 | 10·14 |
| July ... | 5·6 | 9·1 | 11·1 | 18·5 | 5·7 | 7·7 | 10·9 | 12·7 | 13·0 | 7·3 | 8·0 | 16·4 | 9·3 | 13·2 | 8·3 | 9·0 | 9·8 | 8·5 | 10·5 | 9·9 | 8·6 | 7·5 | 10·06 |
| August ... | 10·1 | 9·7 | 6·1 | 12·8 | 5·4 | 10·4 | 7·9 | 13·6 | 13·2 | 13·3 | 13·2 | 9·5 | 12·3 | 10·8 | 9·1 | 10·0 | 13·5 | 6·0 | 5·5 | 13·4 | 10·9 | 8·5 | 10·45 |
| September | 5·2 | 4·2 | 13·1 | 11·9 | 7·1 | 17·2 | 7·1 | 6·9 | 25·2 | 8·6 | 7·1 | 21·2 | 9·6 | 6·1 | 8·3 | 8·3 | 9·3 | 8·6 | 8·9 | 6·0 | 9·9 | 10·0 | 10·02 |
| October ... | 12·0 | 9·4 | 10·6 | 8·4 | 21·0 | 13·2 | 4·8 | 12·2 | 10·9 | 7·0 | 9·8 | 3·9 | 7·8 | 12·3 | 9·8 | 8·0 | 11·5 | 8·2 | 9·7 | 10·3 | 11·7 | 7·0 | 10·02 |
| November | 7·3 | 11·6 | 8 3 | 11·4 | 7·8 | 17·3 | 17·4 | 11·4 | 12·2 | 11·8 | 6·8 | 7·9 | 12·7 | 6·2 | 6·1 | 9·7 | 8·5 | 7·8 | 4·8 | 8·5 | 5·3 | 11·5 | 9·60 |
| December | 12·5 | 3·7 | 6·1 | 6·8 | 4·8 | 12·1 | 10·9 | 10·3 | 6·1 | 5·9 | 3·1 | 11·5 | 9·3 | 16·4 | 3·9 | 3·9 | 5·1 | 7·7 | 17·5 | 6·7 | 5·6 | 3·9 | 7·93 |
| | 88·11 | 70·15 | 109·67 | 113·60 | 81·55 | 121·29 | 113·93 | 111·26 | 107·49 | 84·64 | 73·25 | 99·71 | 91·43 | 86·81 | 77·72 | 72·64 | 81·84 | 71·33 | 79·98 | 85·43 | 108·01 | 110·18 | 92·7 |

## Table II.

| Rain-gauge station. | Inches of rainfall for the year 1909. | Rain-gauge station. | Inches of rainfall for the year 1909. |
|---|---|---|---|
| A | 83·51 | H | 84·65 |
| B | 85·43 | I | 87·71 |
| C | 99·55 | J | 95·65 |
| D | 94·79 | K | 76·75 |
| E | 97·01 | L | 79·34 |
| F | 62·97 | M | 124·14 |
| G | 68·72 | | |

## Table III.

| Day of Month. | I. A typical month in the dry season. March, 1909. | | | II. A typical month in the wet season. October, 1909. | | | III. A favourable Anopheline month. November, 1911. | | | IV. May, 1910. | | | V. February. 1911. | | | VI. 1909. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. | B. | C. | A. | B. | C. | A. | B. | C. | A. | B. | C. | A. | B. | C. | May. | June. | July. |
| 1 | ·02 | — | — | ·45 | ·02 | — | 1·65 | 3·33 | 1·77 | ·48 | — | ·87 | ·65 | 1·05 | ·44 | — | 1·01 | — |
| 2 | — | ·01 | — | ·05 | ·02 | — | ·15 | ·09 | ·27 | 1·51 | — | ·10 | 1·95 | ·65 | 1·56 | ·10 | ·32 | ·22 |
| 3 | ·18 | ·25 | ·10 | — | — | ·28 | ·04 | — | ·12 | ·10 | ·67 | ·13 | 1·90 | ·55 | ·45 | ·10 | ·01 | ·11 |
| 4 | ·20 | ·15 | — | ·22 | — | — | ·12 | ·02 | ·18 | 1·12 | ·52 | ·42 | ·19 | 1·80 | ·37 | ·02 | — | ·14 |
| 5 | ·12 | ·23 | — | 1·46 | ·30 | 2·45 | ·15 | — | ·14 | ·37 | ·24 | ·70 | 2·05 | 1·12 | 2·20 | ·10 | ·01 | ·02 |
| 6 | ·38 | ·65 | ·17 | ·30 | 2·30 | ·40 | ·22 | ·14 | ·23 | ·06 | ·09 | ·23 | ·81 | 1·30 | 1·37 | — | — | — |
| 7 | ·05 | ·05 | ·76 | ·20 | ·18 | — | ·05 | 1·00 | ·02 | ·16 | ·40 | ·15 | 4·04 | ·20 | 7·80 | — | ·05 | ·25 |
| 8 | ·11 | ·12 | ·10 | ·19 | ·14 | ·35 | ·02 | ·26 | ·17 | ·02 | ·30 | ·17 | ·53 | ·20 | ·35 | ·07 | ·03 | ·10 |
| 9 | ·15 | ·16 | ·13 | ·05 | ·85 | — | ·12 | ·40 | ·14 | — | ·10 | ·74 | 4·23 | ·30 | ·90 | ·01 | — | — |
| 10 | ·30 | ·30 | ·10 | — | ·22 | — | ·21 | ·13 | ·11 | ·12 | ·21 | ·16 | ·02 | — | — | ·81 | ·29 | ·11 |
| 11 | ·03 | ·17 | ·12 | — | — | — | ·72 | ·28 | ·68 | ·77 | ·12 | ·14 | ·10 | — | — | ·18 | ·10 | ·16 |
| 12 | ·16 | — | ·16 | — | — | — | ·16 | ·51 | ·13 | ·50 | 2·62 | ·26 | — | — | — | — | ·20 | ·06 |
| 13 | ·30 | ·12 | ·09 | ·54 | ·15 | — | ·32 | ·29 | ·46 | ·17 | — | 1·45 | — | — | — | ·02 | ·12 | ·31 |
| 14 | — | — | — | ·09 | ·22 | ·33 | ·08 | ·02 | — | ·78 | ·78 | ·20 | — | — | — | ·02 | ·21 | ·67 |
| 15 | — | — | — | ·78 | 1·80 | 1·00 | ·22 | ·22 | ·06 | 1·59 | 1·28 | ·77 | — | — | — | ·01 | ·05 | ·56 |
| 16 | — | — | — | ·60 | 1·27 | ·48 | ·75 | 1·38 | ·70 | — | — | ·40 | — | — | — | — | ·07 | — |
| 17 | — | — | — | 2·86 | 1·46 | — | 1·00 | ·47 | ·50 | ·32 | ·22 | — | — | — | — | — | ·33 | — |
| 18 | — | — | — | ·09 | — | — | ·37 | ·15 | ·85 | ·16 | ·40 | ·16 | — | — | — | — | 1·22 | ·01 |
| 19 | — | ·01 | — | ·06 | ·20 | ·30 | ·04 | ·02 | ·09 | ·60 | ·65 | ·32 | — | — | — | — | 3·05 | ·42 |
| 20 | — | — | — | ·05 | — | ·52 | ·26 | ·20 | ·17 | ·72 | ·68 | ·24 | — | — | ·07 | 1·01 | ·30 | ·29 |
| 21 | — | ·02 | — | ·05 | — | ·05 | ·06 | ·30 | ·04 | — | — | ·05 | — | — | — | — | ·81 | ·40 |
| 22 | — | — | — | ·14 | — | — | ·27 | ·19 | ·08 | ·92 | ·20 | ·24 | — | — | — | — | ·27 | ·15 |
| 23 | — | — | ·03 | — | — | — | ·02 | — | ·04 | ·03 | — | — | — | — | — | ·08 | ·13 | ·15 |
| 24 | — | — | — | ·11 | ·56 | — | ·20 | ·14 | ·09 | 2·80 | 2·48 | ·44 | ·01 | — | — | — | ·50 | ·10 |
| 25 | — | — | — | 1·25 | 1·00 | — | ·21 | ·14 | ·38 | 2·33 | 3·37 | 1·90 | — | — | ·03 | ·15 | ·38 | ·35 |
| 26 | — | — | — | — | — | — | ·02 | — | ·16 | 2·23 | 1·66 | 1·41 | ·08 | — | ·10 | ·05 | ·01 | ·15 |
| 27 | — | — | — | ·12 | — | ·20 | ·05 | ·06 | ·13 | ·37 | 3·00 | 1·10 | ·06 | — | ·17 | ·08 | ·15 | ·20 |
| 28 | — | — | — | — | — | ·20 | ·11 | ·12 | ·05 | ·11 | ·63 | ·109 | — | — | ·05 | ·22 | ·05 | ·90 |
| 29 | — | — | — | ·01 | ·21 | ·20 | 1·23 | ·65 | ·75 | ·70 | ·33 | ·25 | — | — | — | ·02 | ·51 | 2·11 |
| 30 | — | — | — | ·32 | — | — | ·18 | ·16 | ·13 | ·80 | 1·28 | ·10 | — | — | — | ·42 | ·02 | 1·83 |
| 31 | ·06 | ·03 | — | ·31 | ·43 | ·98 | — | — | — | 2·02 | 2·48 | 1·83 | — | — | — | 1·01 | — | ·22 |
| Totals ... | 2·06 | 2·27 | 1·74 | 10·32 | 11·53 | 7·74 | 9·00 | 10·67 | 8·64 | 21·95 | 24·68 | 16·02 | 16·64 | 7·17 | 15·86 | 4·47 | 10·2 | 9·99 |

The columns A. B. and C. show the records from three different stations.

Fig. 1. Non-permanent breeding-ground of Anophelines.

Fig. 2. Swampy pasture land which yielded no Anopheline larvæ.

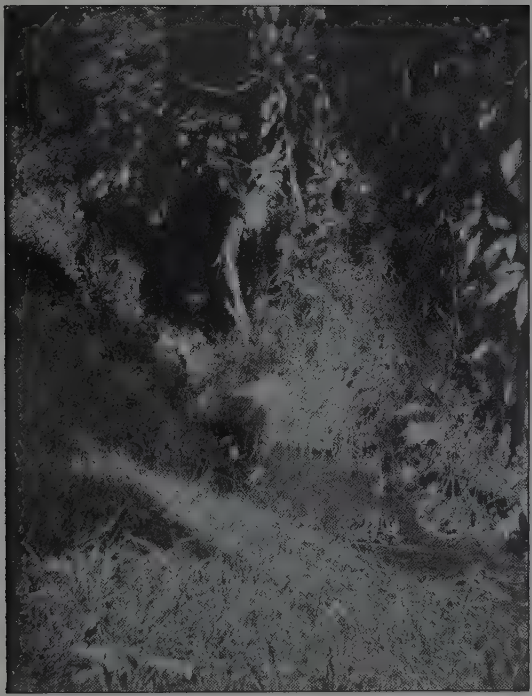

Fig. 1. Breeding-place in roadside ditch.

Fig. 2. Breeding-ground produced by the wallowing of pigs.

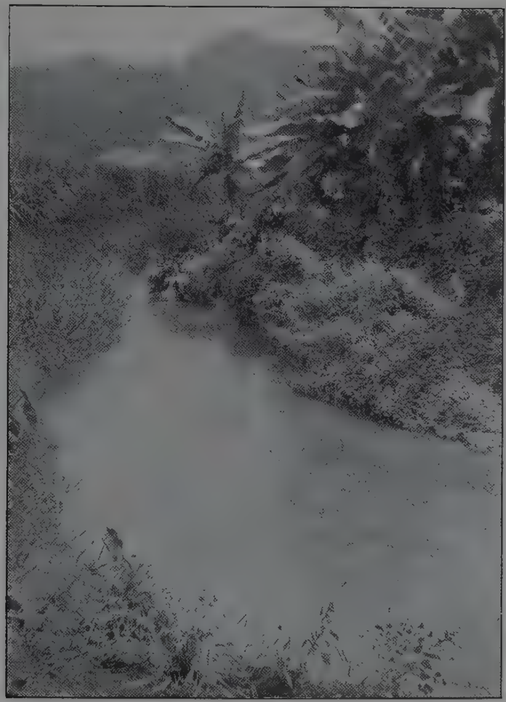

Fig. 1. A swiftly-running stream in which no larvæ were found.

Fig. 2. The same stream, near its mouth; here larvæ were found.

Fig. 1. Back-water of the same river as on Plate VIII.; here larvæ are controlled by small fish.

Fig. 2. Muslin tent used for breeding mosquitos *in situ*.

# ON THE UTILISATION OF AN INDIGENOUS AFRICAN SILK-WORM (*ANAPHE INFRACTA*, WLSM.) IN UGANDA.

By C. C. Gowdey, B.Sc., F.Z.S., F.E.S.,
*Government Entomologist of Uganda.*

The silkworms which are found in the largest quantities in Uganda belong to the genus *Anaphe* (family Eupterotidae), of which we have three species, *Anaphe infracta*, Wlsm., *A. venata*, Butl., and *A. moloneyi*, Druce. The other species of silkworms which have so far been observed in the Protectorate are *Mimopacha gerstaeckeri*, Dew., and *Hypsoides milleti*, de Juan, but these are comparatively rare. This paper deals only with *Anaphe infracta*.

## Description of Adult.

The wings of the moth are of a creamy white colour; the anterior wings have broad bands of dark brown—two broad bands in the middle of the wing joining at the posterior margin to form a V, and two sub-parallel bands of the same colour join the outer arm of the V to the lateral margin; the lateral margins of both the anterior and posterior wings are also bordered with dark brown, but the border of the latter is not so pronounced. The segments of the abdomen are marked with rings of golden-brown hairs. The female differs from the male in being larger and having the tip of the abdomen covered with golden-brown hairs.

## Life-history and Habits.

There are two broods in a year, and, as the life-cycle of each brood takes about a year to complete, the broods overlap each other. The adults of one brood emerge from the cocoon-mass, or nest, in September and of the other in January. The only marked difference in the duration of the metamorphoses of the two broods is in the chrysalis stage; in the September brood the length of this stage is about thirteen weeks, whereas in the January brood it is about six weeks. Below is given the duration of the stages of the two broods in tabular form for comparison:—

| Stage of Insect. | Length of Stage (in days). | January Brood. | | September Brood. | |
|---|---|---|---|---|---|
| | | From | To | From | To |
| Egg ... ... ... | 45 | Dec. 15 | Jan. 31 | Aug. 1 | Sept. 15 |
| Larval ... ... ... | 107 to 150 | Feb. 1 | June 30 | Sept. 15 | Dec. 31 |
| Spinning of Cocoon ... | 120 | July 1 | Oct. 31 | Jan. 1 | April 30 |
| Chrysalis... ... ... | 45 to 92 | Nov. 1 | Dec. 15 | May 1 | Aug. 1 |
| Life of Adult ... ... | 5 to 6 | Dec. 16 | Dec. 21 | Aug. 1 | Aug. 7 |

The table shows that the life-cycle occupies from 322 to 413 days, the longer period being for the September brood, which appears also to be rather smaller than the earlier brood. The dates are, of course, only approximate.

The eggs are laid on the under-side of the leaf of the food-plant in large clusters. These clusters, which contain from 200 to 300 eggs, are covered with the silky

golden-brown hairs from the apex of the abdomen of the female moth. The larvae feed in groups or colonies, and dislike sunlight. They are very voracious, devouring the foliage with great rapidity, but they do not appear to feed on the very old leaves. Towards the end of the larval period the larvae establish themselves in the bifurcations of the branches of the tree on which they have been feeding and begin to build a large cocoon-mass, or nest, of soft silk, which they occupy. The colour of the nest varies, but it is most often of a ferruginous brown. When the nest is finished and the larvae are ready to pupate, they go inside and each encloses itself in a small cocoon.

The nests vary greatly in shape and size; sometimes, with the live larvae, they weigh as much as six to eight pounds, and contain from 120 to 600 or even 800 insects.

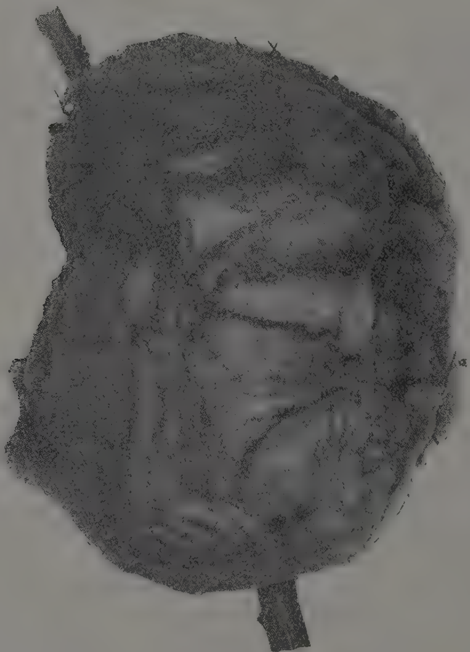

Fig. 1.—Nest of *Anaphe infracta*, Wlsm.

On examination of the nests it will be seen that they consist of three envelopes of silk. The first or outer envelope is composed of very fine silk, but fairly strong and long. The second envelope consists of several layers of silk, placed so close together that it has the appearance of a layer of sheets. The third envelope is of the texture of parchment, and is also formed of several layers of silk. This last envelope is hard and extremely resistant, but the silk of which it is composed is better than that of the other two. The separate cocoons within the nests are made of fine silken threads, but their value is diminished by

the presence of a large percentage of dirt and foreign matter. The silk of these cocoons contains less colouring matter than that of the envelopes, which is probably due to the absence of light.

The handling of the nests causes irritation to the skin, as they contain urticating hairs, derived from the bodies of the larvae, the effect of which on the epidermis is very painful.

## Food-Plants.

The food-plants of *A. infracta* are *Bridelia micrantha*, var. *ferruginea* (Luganda, "Katasemite"), *Cynometra alexandri* (Luganda, "Nongo"), and *Triumfetta macrophylla* (Luganda, "Beinsamwe"): and in the Belgian Congo it is reported to feed on *Albizzia fastigiata*. *Bridelia*, however, is the favourite food, being invariably eaten in preference to the others. This plant is a bushy shrub, attaining a height of from eight to fifteen feet, and bearing numerous spines on its branches.

Repeated attempts were made, without success, to feed the larvae of this silkworm on mulberry and on a species of wild fig ("bark-cloth tree"). It was hoped that, by feeding the larvae on the former, the quality of the silk might have been improved.

## Rearing the Larvae.

The food-plant (*Bridelia*) can be grown either from seeds or from cuttings. The latter method is preferable, as the trees attain the required size for feeding the larvae much sooner, and it will be found that they grow quite readily from cuttings. The trees should not be planted further apart than six feet, and it may be found advantageous to adopt closer planting, for the reasons that the silkworms must have plenty of shade and also must be left undisturbed, which cannot be done if the trees are planted so far apart that the weeds grow readily between them, necessitating constant weeding.

When the trees are about a year old they should be "stocked" with larvae. At this age each plant should have sufficient leaves to support a colony of about 100 larvae. The trees may be stocked either with egg-masses or nests. The egg-masses are the more difficult to handle, but, on the other hand, the use of nests is apt to aid in distributing parasites. When the nests have been completed, they may either be left on the food-plant for the adults to emerge or they may be collected and removed to a specially built breeding-house. Both methods have their advantages and disadvantages. If the nests are removed from the trees, there is a risk of disturbing the larvae, which remain for a considerable time in the nest without pupating, and some of them will show their resentment at being disturbed by leaving the nests, and this represents a dead loss of larvae. Yet, if the nests are left on the tree for the adults to emerge under natural conditions, no control can be kept over the parasites which feed on the larvae and pupae within the nests and which would presumably increase from year to year. The question arises, therefore, whether more larvae are lost through the disturbance of the nests than would be lost by the unchecked depredations of the parasites; but this is a point that cannot be settled without

further careful investigation. Whether the nests are removed from the food-plant or not, the trees should be pruned so as to have a fresh supply of young leaves for the larvae of the next brood to feed on, as they will not eat the old tough leaves.

The cardinal points to be borne in mind in the rearing of this silkworm are—(1) that the larvae require a large supply of food; (2) that shade is essential for their well-being; and (3) disturbance of the larvae is fatal.

## Treatment of the Nests.

After the moths have emerged a cut should be made in the outer envelope of the nests and they should then be allowed to soak in water for about thirty minutes. The reason for this, and subsequent, soaking is that the handling of the dry nests is attended by severe irritation of the skin, caused by the hairs contained in the nests. The first envelope is now removed and the nests are

Fig. 2.—Soaking nests of *Anaphe* in order to soften the urticating hairs.

again soaked, after which the second envelope is removed and separated into its several layers. Another soaking is necessary both before and after the removal of the third or parchment-like envelope, so that the nests should be soaked four times in all. After the removal of the third envelope only the

mass of separate or loosely attached cocoons remains, the silk of which is the least valuable. From them all the foreign matter and the cast skins of the larvae and pupae should be removed. The silk of the three envelopes and that of the cocoons should be kept separate, and after being pressed should be packed for shipment in separate bales.

In common with the Eri or Castor Silkworm (*Attacus ricini*), the silkworms of the genus *Anaphe* have an immense advantage over the Mulberry Silkworm (*Bombyx mori*), in that the cocoons do not require to be "stifled," that is, killed, to prevent the egress of the moth.

With a view to obtaining supplies of wild silk, it would be advisable to draw the attention of the natives to the fact that it is to their interest no longer to destroy the nests of *Anaphe*. Indeed, the collecting and propagation of these insects might well become a source of profit to them, as they would readily be able to sell the nests, at a price fixed by agreement, to any company exploiting this product.

## Natural Enemies.

As might be expected from its manner of living in large colonies, *A. infracta* does not enjoy a perfect exemption from predaceous or parasitic attack. The insects and birds mentioned here as attacking the silkworm I collected in Bukoba District, German East Africa, and in Uganda.

*Birds.*—The chief predaceous enemies of this moth appear to be birds, of which I have observed three species actually feeding on the larvae and have found the insects in their stomachs :—*Chrysococcyx cupreus* (Golden Cuckoo), *Pycnonotus layardi* (Layard's Bulbul ; Luganda, "Sosolia"), and *Motacilla campestris* (Yellow Wagtail ; Luganda, "Kalisa"). Of these, *Pycnonotus layardi* is the worst enemy. These birds, however, apparently attack the larvae only during the first instar, before the appearance of the irritating hairs, which presumably make the larvae distasteful or obnoxious.

*Parasitic Insects.*—The silkworm is attacked by other insects in almost every stage of its development.

The eggs are attacked by a minute Chalcidid parasite, *Telenomus gowdeyi*, Crawford (subfamily SCELIONINAE), which I first discovered in Bukoba. At first I considered this to be the most serious of the parasites which attack this silkworm, but I have since found another new Chalcidid, *Pleurotropis telenomi*, Crawford (subfamily EULOPHINAE), which in its turn parasitises *T. gowdeyi*. This secondary parasite will probably maintain a balance between the primary parasite and the host.

From the cocoons two parasites have been bred, an as yet unidentified fly (coll. no. 2315) of the family TACHINIDAE and *Cryptus* (*Oncilella*) *formosus*, Brullé, a species of parasitic wasp of the family ICHNEUMONIDAE. *C. formosus* is a shining blue-black insect, having the middle of the antennae banded with white, the head and pronotum partly red, and the wings blue with a broad hyaline band. This parasite pierces the nest with its ovipositor, laying its eggs in the larvae of the silkworm, and the larvae of the *Cryptus* on hatching feed on the larvae and pupae of the host. If the nests are collected from the

trees and placed in houses, any parasites can easily be destroyed on emergence. Also, if the eggs of the silkworm be used instead of the nests for stocking new plantations the spreading of these parasites will be lessened.

In West Africa, in addition to *C. formosus* two other parasites have been found infesting the cocoons of *Anaphe*, namely, the larvae of two Pyralid moths, *Metoecis carnifex*, Coq., and *Metoecis sp.*? of the subfamily PHYCITINAE.

This silkworm has not been found to be subject to any of the usual silkworm diseases.

# NOTES ON THE BLOOD-SUCKING INSECTS OF EASTERN TROPICAL AFRICA.

By S. A. Neave, M.A., B.Sc. Oxon.

(Plates X. and XI.)

Owing to the very limited time available during my stay in England, it has not seemed advisable to attempt any general account of so extensive a region as that covered by my recent journey through Tropical East Africa. This region extends practically from the Zambesi River to the Upper Nile, and is included in 12 degrees of longitude and no less than 22 parallels of latitude. It comprises all types of country from open plains to dense forests, and elevations from sea-level to 10,000 feet. This area includes, in addition to a large portion of the Eastern Tropical subregion, a small portion of the South African subregion and. in Uganda, of the Western Tropical subregion. The entomological study of so large an area involves a great variety of interesting questions and an even more bewildering diversity of insect life. The economic relations of these numerous species with man and his domestic animals present a large number of problems, in regard to many of which much additional evidence is required.

One of the most urgent of these problems at the present time in Eastern Africa, or indeed in any part of the continent, viz.: the occurrence of human trypanosomiasis in Nyasaland and Northern Rhodesia, outside the distribution of *Glossina palpalis*—is already being studied by two Commissions on the spot.

Apart from this important question, all the countries under discussion have to contend with other diseases borne by blood-sucking organisms, and it is clear that all the local Governments, especially in Nyasaland and on the coast belt of British East Africa, will find it imperative during the next few years to spend large sums in combating these serious hindrances to human progress in Tropical Africa.

From the entomological standpoint it is of the utmost importance that too fine a line should not be drawn between the insects which, in the present very limited state of our knowledge, we believe to be noxious and those which are considered to be innocuous. If entomological workers are to be of the greatest possible assistance to medical science, it is their duty to collect all available data about *all* blood-sucking organisms. They will thus be fore-armed with knowledge of inestimable value should any species, at the moment believed innocuous or only under suspicion, become incriminated as a disease-carrier.

The following paper will therefore be confined to the blood-sucking arthropods, mainly Diptera, collected during the tour, with the exception of a few records of biting flies taken on previous journeys in Northern Rhodesia, in 1904, 1905 and 1908. The great bulk of the collection was made during the writer's recent tour on behalf of the Entomological Research Committee in 1910 and 1911. During this period the greater portion of the three British Protectorates, Nyasaland, British East Africa and Uganda, were visited, and portions of Northern Rhodesia and German East Africa were traversed.

In the course of this survey over 5,000 miles were covered with native porters, exclusive of railway or steamer journeys. A very large collection of all forms

of insect life was made, comprising about 100,000 specimens, of which about 15,000 were blood-sucking arthropods.

I am glad to be able to take this opportunity of expressing my best thanks for the unvarying assistance and hospitality I everywhere received during the course of my tour. My especial thanks are due to the Principal Medical Officers of the three Protectorates, viz. :—Dr. H. Hearsey at Zomba, Dr. A. D. Milne at Nairobi, and Dr. A. P. D. Hodges, C.M.G., at Entebbe, who rendered me every possible assistance.

In addition to somewhat detailed records of my collection, I have endeavoured to bring up to date lists of the known species of biting arthropods from each of the countries under discussion. These lists must not be regarded as by any means complete, but if they be compared with those given in Mr. E. E. Austen's "Illustrations of African Blood-sucking Flies" (1909), some idea will be gained of the great increase in our knowledge of these insects that has been effected in the last few years.

I have also added, as an appendix, a provisional list of the native names of the principal blood-sucking insects and ticks in Eastern Tropical Africa.

The identification of so large a number of species as those recorded in this paper has been a most laborious task, and the writer's best thanks are due to those who have done a large part of this work, particularly Mr. E. E. Austen, Mr. F. W. Edwards, Professor R. Newstead, F.R.S., Professor G. F. Nuttall, F.R.S., and Mr. C. Warburton. Finally the writer is most deeply indebted to Mr. Guy A. K. Marshall who, in spite of a great press of work, has found time not only to help much in identification but to assist in a great variety of ways throughout the production of this paper.

Before giving particulars of the insect themselves a few notes on general methods of collecting may perhaps be of interest. It is not necessary to lay down any special instructions for collecting such insects as biting flies, since, to a large extent, they come to the collector instead of having to be searched for. Special methods have however to be adopted in collecting the males of those groups in which only the female sex bites, as in the TABANIDAE, but these will be discussed under that family.

Given the time to train them, I have always found native collectors to be invaluable. Young boys of from 12 to 15 years of age usually seem to be the most satisfactory. If older than this, they are slower to learn, take less interest in their work, and are not so energetic or active. Personally, I have always found a system of partial payment by results most satisfactory. My collectors have usually been paid the lowest local monthly rate of wages, but in addition often earn 25–50 per cent., or even more, per month according to their success. This system not only encourages them to work hard but gives them a definite interest in the insects themselves, as the additional pay is given for special insects, such as, in the case of biting flies, male Tabanids or individuals of species not at all, or very little represented in the collection.

The different tribes of East African natives seem to differ to a remarkable extent in their capacity for this kind of work. Though some of the North East Rhodesian tribes are good, particularly the Awemba, by far the best come from Nyasaland, notably those of Yao stock. The natives of British East Africa

developed only exceptionally into really useful collectors, while those of Uganda, of whom I had expected much, seemed altogether to lack the necessary energy and enterprise.

The secret of successful insect collecting in Africa lies largely in the careful organisation of equipment and native assistants. As soon as a competent staff has been got together the amount of work which can be got through is almost unlimited. This, of course, necessarily takes time. It is always well worth while to expend time and trouble in teaching each new collector, since the native learns to do his work in the right way just as easily as in the wrong. He is, however, such a creature of habit, that having once learned wrong methods it becomes extraordinarily difficult to get incorrect ideas out of his head.

So far as equipment for native collectors is concerned, the writer always armed half his staff with large kite nets having long handles, a box of papers for Lepidoptera, Neuroptera, &c., a tube charged with chloroform on cotton wool, and one or two pill-boxes. In addition to biting flies these boys chiefly collected insects suitable for papering. The long nets were found very necessary for many biting flies, especially TABANIDAE drinking at damp sand or attacking domestic animals, occasions when they are usually very wary. A very useful adjunct to the equipment is a satchel or some form of haversack, since it must be remembered that natives seldom possess pockets!

The other half of the staff were supplied with small, short-handled, round nets, about a foot to fifteen inches in diameter, cyanide bottles, and small tubes and pill-boxes for Diptera or other delicate insects. These boys, in addition to biting flies, collected principally Coleoptera, Hymenoptera, Hemiptera, etc. They were usually instructed to work in couples, one of each class, so that they might be of mutual assistance and between them prepared for all emergencies.

When not on the march the boys usually worked from about 9 a.m. to 3 or 4 p.m. Special work, such as searching for the species of *Glossina* with crepuscular habits, was of course also done when necessary. These native collectors are easily taught to keep separate, predaceous ASILIDAE or other insects taken with prey, or two individuals taken "in coitu." It is however unfortunately most inadvisable to give rewards for specimens of this kind, as by so doing a doubt at once arises as to the facts.

With the more intelligent boys I found it of great value to stimulate their interest by showing them pictures, coloured if possible, of biting flies or any specially wanted insect.

## Order DIPTERA.

### Family **Chironomidae.**

The bulk of the midges and other small biting insects in my collection have not yet been fully worked out systematically. It is therefore not possible to give more than a general account of each genus.

#### Genus CULICOIDES, Latr.

These small midges are far better represented in Uganda and the Nyanza Province of British East Africa than in any of the other countries under discussion. No less than five species are known from that region, and there are

probably more to be discovered. The most abundant of these species is *C. grahami*, Aust., which I found in vast numbers in the forests of the Semliki Valley, in November 1911. It was there a most terrible pest, and made life almost unbearable. The hours when it was worst were between 8 and 10 a.m., and from about 4 p.m. until sunset. It did not bite after dark.

One species, which appears to be new to science, was taken near the sea-shore at Lamu, British East Africa, and presumably breeds in salt or brackish water. It is said to be a great pest at certain seasons.

### Genus Johanneseniella, Will.

This genus is only known from Africa, up to the present, by two females of the recently described *Johannseniella fulvithorax*, Aust., which I took in May 1911, on the Yala River, in North Kavirondo, British East Africa. They were taken at night, shortly after sunset.

### Genus Ceratopogon, Mg.

A few insects of this genus were taken on the southern slopes of Mount Elgon, in June 1911. The Research Committee have also received it from Nyasaland from Sir David Bruce, on whose authority it is stated to attack man. Dr. Spurrier, of Zanzibar, also states that insects of this genus are a serious pest there.

## Family **Culicidae.**

It is not possible for lack of time to give a detailed account of the mosquitos collected, though the records of all the species obtained are included in the general list. Apart from this, the collection made was by no means a representative one, it being very difficult to collect these insects at all exclusively when constantly on the move. Among the more interesting species taken was *Skusea pembaensis*, Theo., of which a few specimens were obtained in March 1912 near Lamu, British East Africa. It attacks man readily, but was only really troublesome for an hour about sunset and again at sunrise. It seems to occur only on the sea-shore, often great distances from fresh water, and presumably breeds in the sea. The most interesting mosquitos from an economic standpoint are of course the Anophelinae, the carriers of malaria. They are widely distributed in all the countries under consideration, but certainly seem scarcer in individuals, if not in species, in the damper parts of Western Uganda than, for instance, in the drier and more open country to the north or in the Nyanza Province on the eastern side of the Lake. In this latter region several species, particularly *Anopheles* (*Myzomyia*) *costalis*, are extraordinarily abundant, and malaria is consequently very prevalent.

## Family **Simuliidae.**

### Genus Simulium, Latr.

The species of this genus, of which several were taken over a large area, have not yet been systematically studied. They seem to be chiefly numerous in well-wooded, damp localities, often at considerable elevations, as on the slopes of Mt. Kenya.

## Family **Psychodidae.**

### Genus PHLEBOTOMUS, Rond.

Representatives of this genus were taken in Northern Rhodesia and Nyasaland, which will shortly be described by Professor Newstead as a new variety of *P. minutus*, Rond. They were mostly taken at light, immediately after sunset, in damp localities, and seemed but little inclined to bite.

## Family **Tabanidae.**

This family includes by far the greatest number of African biting flies. These insects are often exceedingly numerous, and during my last tour, 9,591 specimens were collected, of which 3,649 were males. The period, however, when these flies are on the wing is often a very short one, and in regions with well marked wet and dry seasons, is usually confined to the former.

TABANIDAE generally become noticeable in large numbers at the beginning of the rains, though, as I shall explain later, many species probably emerge from the pupa some time before the first rains fall. In some species at any rate there appears to be a second brood about the end of the rainy season, and in certain *Haematopota* and *Chrysops* there would seem to be several broods in the year.

In East Africa, in the country south of about 9° S. Lat., there is normally only one wet season, which lasts from about November to April, May to October being dry. The best months therefore for TABANIDAE in Nyasaland and Northern Rhodesia are November to January. A limited number also occur throughout the rainy season up to the end of April or beginning of May. During the cool dry weather of June, July and August practically no TABANIDAE are to be found, and they probably spend this period in their larval stages.

In the Luangwa Valley, North-Eastern Rhodesia, judging by my experience there in 1910, many species, especially of *Tabanus*, begin to emerge from the pupa during September and October. They are, however, during this time but little in evidence until the first rains fall at the end of October or beginning of November. During this period, immediately before the rains, more particularly in the genus *Tabanus*, the males were at least as numerous as the females, and the latter seemed not to be much in search of vertebrate blood. They might therefore be overlooked at this time, unless specially sought for.

Like nearly all biting Diptera, these insects appear to be peculiarly sensitive to climatic conditions. Different genera vary in the conditions of sunshine, amount of humidity, etc., which influence the times at which they are inclined to feed. A certain degree of humidity of the atmosphere, even if only temporary, would seem to be an essential factor in impelling the females to seek for vertebrate blood. During the extremely dry hot weather which is usual before the rains break, it is remarkable how little inclined to bite the females of most species seem to be. Thus during September and October 1910, in Northern Rhodesia and Nyasaland, over two thousand individuals of some twenty-five species were collected. These were almost entirely taken in the immediate vicinity of water, either drinking at wet sand or mud, or resting on the reeds and grasses near by ; a few of the males were also frequenting flowers. There

can be no doubt that in very hot and dry weather, such as at the time mentioned, both sexes absorb considerable quantities of water. During this period the females very rarely attacked animals or man, the natives alone appearing to be bitten, and then only occasionally, when actually at the water-holes where the flies were swarming.

As I have already pointed out,* some of the more fragile and slender species of *Tabanus* appear to be able to drink by alighting on the surface of the water and passing the proboscis through the surface film. Though I have never actually seen it happen, I am inclined to think from their behaviour that some species of *Haematopota* and *Chrysops* do the same, since I have once or twice seen the males skimming to and fro over the surface of the water, apparently wishing to alight upon it.

In British East Africa the conditions in respect of TABANIDAE are somewhat different and more complicated, since there are two fairly well marked rainy seasons. The most important of these is that from the end of March to about the end of May, there being another short rainy period about November. In this region therefore most species will probably be found to have at least two broods during the year. The hottest and driest months are from the beginning of January to the middle of March, and at this period few if any TABANIDAE are to be found, at least in the lower-lying parts of the country. When however I was in the hot dry country near Voi, in March 1911, I found some evidence that several species emerge from the pupa a week or two before the rains break in the low ground, as in Nyasaland and Rhodesia. On the other hand, in the much cooler and less dry highlands, especially in the more forested parts, as on the slopes of Mt. Kenya and on the Aberdare range, many species of *Haematopota* were on the wing during the driest season and therefore probably all the year.

In Uganda the conditions are again somewhat different. There, though there are nominally two wet and two dry seasons, they are very ill-defined, except in the Nile valley and parts of Ankole. The natural consequence of this is that, owing to the more or less humid conditions all the year, many species of TABANIDAE, especially the forest-loving ones, seem to be on the wing throughout the cycle of the seasons.

Thus it will be seen that the best time for collecting TABANIDAE in Eastern Tropical Africa, especially the males, is immediately before and after the beginning of the rains. Since the males appear seldom to stray very far from their breeding-places, they should, particularly in the case of *Tabanus* and many species of *Haematopota*, be searched for in the immediate vicinity of water, on the damp mud or sand in river beds or on the vegetation bordering it. The drier the country is, and particularly if the river is reduced to isolated pools, the better the chance of success, since the drinking places are thus much more easily located. In a running stream in such a season I have taken some numbers of both sexes basking in the sun on branches of trees and shrubs overhanging the water. A rock or log of wood just above the surface of the water is also a very attractive spot, and I have often seen my collectors attracting many TABANIDAE and other Diptera by scattering water on such surfaces.

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* Bull. Ent. Res. I, p. 311.

In the case of some species of *Haematopota* and *Chrysops* which frequent open short-grass country, both sexes, but more especially the males, may be found in enormous numbers on the grassy land near the water in which they would appear to have bred. In such species large broods of apparently freshly emerged individuals are as likely to be found in the middle or even at the end of the wet season as at the beginning.

Many species of TABANIDAE are certainly attracted by sweet substances, whether honey or the "honey-dew" secreted on plants by such insects as COCCIDAE and APHIDAE, this being especially true of the males. When near Lake Kioga, in August 1911, I captured very large numbers of many specimens of *Tabanus*, males being in the majority, apparently feeding on some sweet substance on the cotton plants of which there were fairly extensive plantations. The flowers of many flowering shrubs are very attractive to these insects, particularly those of the subfamily PANGONIINAE.

With reference to the interesting note from Dr. J. W. Scott Macfie, published in the last part of this Bulletin (p. 223), regarding his capture of TABANIDAE on a tree infested by Coccids, attention should be called to two points. Firstly, the predominance of the males, there being 34 out of 60 individuals; and secondly, his statement, "It is noteworthy that my pony, tethered not 20 yards away, was quite unmolested by flies at the very times when I was catching considerable numbers on this tree."

This is precisely in accordance with my own experience, which is that whenever the males are at all numerous both sexes will be found either feeding on sweet substances or drinking at damp sand, and the females do not show any desire for vertebrate blood. Though further evidence and more systematic observations are required, I think it is very probable that female TABANIDAE will be found to feed on blood only during a certain period of their imago state. This period seems to be subsequent to pairing and to the death of the male individuals, and most probably (though I have no actual evidence of this) before oviposition.

Since this period when the females, at least in the case of *Tabanus*, are in search of vertebrate blood appears also connected with some degree of atmospheric humidity, it would be interesting to know exactly when, in relation to the seasons, Dr. Macfie made his observations. From my own experience I should expect it to have been shortly before the onset of the rains or, less probably, during a dry interval in the rainy season.

The males of those species which frequent forests are usually extremely difficult to obtain, since the general conditions of humidity make it improbable that the insects will be found drinking, even if the favoured spots could be located. Though occasional individuals are to be found sheltering on the underside of leaves of shrubs, flowers which are attractive to them offer the only reasonable prospect of success.

For some reason, which is not quite clear, canvas, either in the form of a tent or stretched on the ground, in the latter case particularly if damp, is peculiarly attractive to many TABANIDAE and some *Haematopota*. I have observed only females to be thus attracted, and what the object of their visits may be is not obvious, since they seldom bite. I am inclined to think that the tent is attractive as affording shade. Species of *Tabanus*, at least, seldom enter a tent

except in bright sunshine, and though always more vigorous in the sun, I should doubt if they can stand very long exposure to its direct rays. Damp cloth stretched on the ground would appear to provide a suitable medium for absorbing moisture, but it also seems to afford *some* attraction even when dry.

With regard to the insect enemies of TABANIDAE in the imago state, there can be little doubt, I think, that they are preyed upon to a considerable extent by both predaceous Hymenoptera and Diptera. Though there has not been time to work out the details, the collections made on my last tour include two examples of Asilid flies preying upon *Tabanus* and no less than nineteen on *Haematopota*, these Asilids representing some eight or nine species. Several of the *Haematopota* were males. The most important Hymenopterous foes of TABANIDAE in Africa, as elsewhere, are probably the fossorial wasps of the genus *Bembex*, though my collection contains only a single example of an attack by these insects, viz.:—*Bembex capensis*, Lep., preying on *Holcoceria nobilis*, Grünb. I have very little doubt that prolonged observation in suitable localities and at the right season would produce numerous instances. The attacks of the *Bembex* would seem to be most usually made when the Tabanid is itself attacking domestic animals, and from the nature of the circumstances only females would be carried off on such occasions. The Tabanids seem to be aware of the presence of these wasps and of the risks they run, for I have noticed in these circumstances that they will settle on cattle only under the belly or between the fore-legs, where it is difficult for the wasps to seize them.

This family is divided into two subfamilies. The first of these the PANGONIINAE is distinguished from the TABANINAE by the presence of spurs on the tip of the hind tibia, and contains a number of rather heterogeneous genera. Two of these, *Chrysops* and *Rhinomyza*, resemble the TABANINAE in their appearance and largely in their habits. The males of these two genera also resemble those of the TABANINAE in having in their eyes two distinct areas of large and small facets. The other genera of the PANGONIINAE, such as *Pangonia* (*sens. lat.*), *Silvius*, *Aegophagamyia*, etc., have unicolorous eyes, with the facets all of one size in both sexes and (except *Silvius*) the head is not completely holoptic, the eyes only meeting in the middle line on the vertex.

The TABANINAE include the two larger genera *Tabanus* and *Haematopota*, as well as *Holcoceria*, Grünb., represented, so far as our present knowledge goes, by a single species. One species of the West African genus *Hippocentrum*, Aust., also comes into the region under discussion, a few specimens of *H. versicolor*, Aust., having been recorded from the forested areas in Western Uganda.

### Genus CADICERA, Macq.

**Cadicera speciosa,** Aust.

My experience of flies belonging to this genus is confined to the above species of which I took four females in rather densely wooded country at the foot of Mt. Kifulufulu on the Iringa-Kilossa road, German East Africa, in December 1910. They were all taken biting native cattle, except one, which entered my tent, but did not attempt to bite. This capture extends the hitherto known range of the genus very much further north.

### Genus PANGONIA, Latr. (*sens. lat.*)

The flies of this genus are well represented in Eastern Africa, particularly to the south. Though usually to be found only in well wooded areas in the eastern region, they seem to disappear as one approaches the more densely forested western districts and no species has as yet been recorded from Uganda.

The bite of the female is severe, but they do not, I think, very readily attack man, at least in the case of species of the subgenus *Diatomineura*. Those that do suck blood also differ somewhat from the TABANINAE in their method of attack, since they usually seem to insert the proboscis without settling, instead of walking over the body of their victim seeking for a suitable spot to bite.

**Pangonia elongata,** Ric.

Two males and three females of this striking species were captured in the valley of the Chambezi, Northern Rhodesia, during April 1908.

**Pangonia comata,** Aust.

I was fortunate enough during a single day's collecting at Rabai, near Mombasa, British East Africa, on 15th March 1912, to obtain three individuals, all males, of this recently described species.* They were taken in some patches of timber on the side of a wooded hill. All three individuals were captured within a few yards of each other, two at about 10 a.m. and one about 2 p.m. Though the whole neighbourhood was carefully searched, no others could be found.

**Pangonia bubsequa,** Aust.

This species is represented in my collection by a single ♀ (a paratype) taken near Petauke, in the Luangwa Valley, Northern Rhodesia, 8th April 1905.

**Diatomineura sp.**

Nine females were taken at the beginning of March on the south-east slopes of Mt. Kenya, British East Africa. They were all captured in more or less dense forests and at elevations varying from 6,000 to 7,000 feet. One or two individuals came into the tent, but they were mostly taken at flowers.

**Dorcaloemus compactus,** Aust., and var. **centralis,** Aust.

This species was taken in some numbers in the Luangwa Valley, Northern Rhodesia, in March 1908; in the Ruo Valley, Nyasaland, in April 1910; and also at Voi, British East Africa, in February and March 1911, 1912. In my experience, it mainly frequents the banks of rivers in rather heavily wooded, low-lying country. It does not seem to bite man very readily, but when it does so, the bite is a severe one. In a native, the shin is generally attacked. One of the Voi specimens appears to be intermediate between *D. compactus* and the recently described *D. woosnami*, Aust.

**Dorcaloemus sp. nov.**

Two males and nine females of this species were captured in the Upper Luangwa Valley, North-Eastern Rhodesia, during March, 1908.

* Austen, Bull. Ent. Res. III, p. 122 (1912).

### Genus Silvius, Mg.

**Silvius fallax,** Aust.

This interesting, recently described species was taken in very large numbers during September and the beginning of October in the lower Luangwa Valley, North-Eastern Rhodesia. The numbers in which it occurred may be realised by the fact that 78 males and 298 females were captured during this period. In spite, however, of these large numbers it was not much in evidence, unless specially looked for in the neighbourhood of water-holes, and nearly all the above specimens were taken under these conditions. The females were very ready to bite natives drawing water at these places, but did not seem to be troublesome at any appreciable distance from the water. At the same time the conditions were somewhat exceptional, there being an average shade temperature at midday of over 110° Fahr., and an intensely dry atmosphere.

### Genus Aegophagamyia, Aust.

**Aegophagamyia pungens,** Aust. (Pl. XI, fig. 10.)

I originally took a single female of this interesting and recently described insect on some mangroves on the beach at Lamu, British East Africa, in February 1912. Subsequently I found it abundant on the shores of the mainland close by. On 21st February 1912, 38 males and 6 females were collected at Wangi, and on the following day 129 males and 8 females on another part of the shore near by. The whole of these were taken on the actual shore, the vast majority of them drinking at damp sand between tide-marks. They were most abundant where there were mangroves, and it seems almost certain that this species must breed in salt water, since the only fresh water in the neighbourhood was in deep artificial wells. I am not aware of an instance of anyone having been bitten by one of these flies on this occasion, but it will be seen that the females were relatively very scarce, and as I have explained elsewhere, in other Tabanidae under similar conditions the females are very little inclined to bite.

The eyes of both sexes are of a rather translucent greyish-green colour, and the male eye has *no* area of large facets above.

### Genus Rhinomyza, Wied.

The flies of this genus seem to be seldom found in very large numbers. They usually frequent damp, well-wooded localities near water. From a limited experience, they certainly appear to be largely crepuscular in their habits, especially as regards their time of feeding.

So far as I am aware, the eyes are always unicolorous, and in the male the head is holoptic, the eyes being large, unbanded, and with clearly marked upper and lower portions of large and small facets respectively.

**Rhinomyza perpulcra,** Aust.

This species is represented in my own collection only by a single female taken on the Yala River, South Kavirondo, British East Africa, in May 1911, but it appears to be not uncommon at certain seasons in Uganda, in well forested localities. The above-mentioned specimen was biting a native soon after sunrise.

**Rhinomyza umbraticola,** Aust.

I found this species not uncommon in the higher ground of the northern portion of North Eastern Rhodesia during a tour there in 1908. It seemed to be a forest species.

**Rhinomyza innotata,** Karsch.

Five females of this species were captured in October 1908, in the lower portion of the Chambezi valley, North East Rhodesia; and two females were taken at Nkata Bay, Lake Nyasa, in November 1910. The two latter specimens were biting a native sitting on the beach, shortly after sunset.

**Rhinomyza concinna,** Aust.

This species is represented by a single male taken in March 1908, in the Upper Luangwa Valley, North East Rhodesia.

Genus CHRYSOPS, Mg.

This genus is represented in Eastern Africa by nine species or subspecies. The flies occur for the most part in well-wooded districts, and occasionally, e.g., *C. funebris*, they are typically forest insects. They are usually rather local, and do not, so far as my experience goes, attack man so readily as, for instance, *Haematopota*. The bite is said, however, to be far more painful than that of species of that genus, though I do not remember ever having personally experienced it. They would appear to bite chiefly under the same conditions as those which favour *Haematopota*.

The eyes of these flies in the female sex exhibit very beautiful and complicated patterns of green, gold and purple. The male eye, as in other TABANIDAE, resembles that of the female in the lower small-facetted area, but is usually, if not always, different in the upper large-facetted portion.

Different species of *Chrysops* exhibit very different types of eye in the male sex. Thus the eyes of the male of *C. centurionis*, Aust., are relatively very large, the head being holoptic. In other species, such as *C. funebris*, Aust., or *C. distinctipennis*, Aust., the eyes of the male are small, and only partially meet in the middle line.

**Chrysops funebris,** Aust.

This is a characteristically forest species, which is not uncommon in the heavily timbered parts of Uganda. It also occurs sparingly in Northern Kavirondo, British East Africa. As in other forest-haunting species of TABANIDAE, the males are not easy to find in numbers. They do not differ from the females in colour. Insects of this species are very fond of sitting on the underside of the leaves of large-leaved shrubs in the forest. In the neighbourhood of Entebbe, where the insect is a common one, I have seen as many as 10 or 15 individuals resting on half-a-dozen adjoining leaves.

**Chrysops longicornis,** Macq.

This appears to be an insect of wide distribution, but I have not seen it anywhere in particularly large numbers. Specimens of my own collecting are limited to three females taken in the lower Luangwa Valley, North East Rhodesia, September 1910, and two females at Simba, on the Uganda Railway,

British East Africa, in April 1911. It seems to bite with some freedom, perhaps more so than most species of *Chrysops*.

**Chrysops fuscipennis,** Ric.

I found this insect not uncommon on and near the south-west shores of Lake Nyasa, in March 1910. Several individuals were taken biting natives. The male is not yet known.

**Chrysops distinctipennis,** Aust. (Pl. XI, fig. 8.)

This is a very common species in the more open parts of the country in Uganda and the Nyanza Province of British East Africa. Very large numbers of both sexes may sometimes be found in open short-grass country near water; thus in two days at Mumias, N. Kavirondo, my collectors brought me 65 ♂♂ and 16 ♀♀ all from a very small patch of ground. The insects were taken sitting on the grasses, the males being more sluggish than the females.

**Chrysops brucei,** Aust. (Pl. XI, fig. 9.)

A common Uganda species, which frequents both well wooded and open country. It is sometimes abundant in the papyrus swamps which commonly fill the hollows in the more hilly country in Uganda. Thus in a papyrus swamp a little north of Lake Isolt, in January 1912, my collectors took in about an hour 86 ♂♂ and 11 ♀♀; while on the somewhat swampy shores of the Lake itself 92 ♂♂ and 9 ♀♀ were taken in one day. Swampy ground, however, does not seem to be essential, since on the shores of a small lake with well-defined banks in the Koki country, Southern Buddu, in October, 195 ♂♂ and 21 ♀♀ were taken in a day and a half.

**Chrysops wellmanii,** Aust.

This species is represented by a single female taken near Luwingu, N.E. of Lake Bangweolo, Northern Rhodesia, in September 1908.

**Chrysops cana,** Aust.

The only specimens of this remarkable little species, in my collection, are the two males already referred to by Mr. Austen.* They were taken on the river at Masongaleni during the heat of the day, and I fancy had only just emerged. The Research Committee have also received a single female of this species from Mr. C. M. Dobbs, District Commissioner at Kericho, British East Africa, taken near that place. This specimen appears to bear out Mr. Austen's view that *C. cana* is allied to, but distinct from, *C. wellmanii.*

The eyes of this species, in the ♂ at least, are unusually coloured for a member of this genus. They are of a deep blue-green, with three small white spots arranged in a triangle, near the outer margin of each eye.

**Chrysops magnifica,** Aust.

The few individuals of this remarkably handsome species recorded by Mr. Austen† were the only ones seen by me. They were nearly all taken in woodland country, biting natives during the heat of the day, in damp weather.

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* Bull. Ent. Res. II, p. 166. † Bull. Ent. Res. II, p. 161.

**Chrysops centurionis**, Aust. (Pl. XI, fig. 6.)

This would appear to be a fairly common forest species in Uganda, though it has probably a very short season and is therefore frequently overlooked. During a few days collecting at Entebbe, between the 1st and 12th September 1911, with the assistance of my collectors, 128 ♂♂ and 17 ♀♀ were obtained. The vast majority of these, females as well as males, were taken on the flowers of shrubs on the outskirts of the forest, in company with a few individuals of *C. funebris*, Aust. The eyes of the ♂ of this species are somewhat remarkable for one of its genus, being very large, so that the head is truly holoptic. They are of a golden yellow colour, with a semi-circular transverse black streak, below which are two black spots, one on each eye.

### Genus Holcoceria, Grünb.

**Holcoceria nobilis**, Grünb. (Pl. X, fig. 10.)

I was fortunate in obtaining a small series of 16 ♀♀ of this striking species on the banks of a heavily wooded stream at the foot of Kifulufulu Mountain, Iringa-Kilossa Road, German East Africa. The species is also known from the northern shores of Lake Nyasa both on the German and British sides, and the Research Committee have also a male of this insect from Chirinda Forest in S. Rhodesia, collected by Mr. C. F. M. Swynnerton. It would therefore appear to have a wide distribution over the more densely wooded parts of Eastern Tropical Africa. The eyes of the female are of a reddish bronze colour with numerous black spots and markings.

### Genus Haematopota, Mg.

The insects of this genus are extremely numerous both in species and individuals in Eastern Tropical Africa. They occur practically everywhere in the wet season and are perhaps more abundant at the higher elevations than in the lower-lying country, in contradistinction to the majority of species of *Tabanus*. The number of species of this genus already known is very large and doubtless many more remain to be discovered, probably more than in the case of *Tabanus*, since they are more local in their habits, and the season when any given species is much in evidence is often a very short one. The range of the genus is, however, very wide, and it is represented in all types of country and at all elevations from sea-level to at least 10,000 feet.

Different types of *Haematopota* seem to frequent rather different types of country. The lighter coloured species such as *H. unicolor*, *H. denshami*, *H. copemani* and their allies are characteristic of rather open short-grass country. The more strikingly marked species, on the other hand, as *H. distincta*, *H. alluaudi* and *H. brucei*, or those of dull but dark coloration, as *H. fusca* or *H. inornata* are principally forest species or at least frequent streams with well wooded banks.

Nothing, at present, is known as to the breeding habits of the African species of this genus. Until some careful work is done by an observer stationed in one spot for an entire cycle of the seasons it is unlikely that our knowledge on this point will be much advanced. It would seem probable that the majority of the

species have two broods at least in the single long wet season of a country like Nyasaland and possibly more in British East Africa, which has two rainy seasons in the year. The tendency of these flies to emerge from the pupa before the advent of the rains is not nearly so marked as in the genus *Tabanus*. This is probably connected with the fact that they require a more humid atmosphere than the insects of that genus. The females usually bite, in Africa at least, in rather dull damp weather and rarely in the heat of the sun, as is the usual habit of *Tabanus*. In very sunny weather they are most in evidence from about 8–10 a.m. and again from 4 p.m to sunset. In exceptional localities, such as cool and shady, damp forests, they may be troublesome all day. The males are usually very sluggish and easily captured if they can be located. They sometimes occur in enormous numbers in one spot, and in Northern Kavirondo, in June, the writer has seen hundreds of these insects crowded together on the short grasses near water. The males of the forest species, however, are extremely hard to locate and are therefore only procurable with difficulty.

The eyes of the female insects of this genus are remarkable objects in life, exhibiting a complicated pattern of iridescent colours which could only be satisfactorily denoted by a coloured drawing. As the colours and patterns are of diagnostic value it is to be hoped that some of the collectors who are kindly assisting the work of the Committee will, if time avails, endeavour to send coloured sketches of the eyes of these insects with their specimens. The relation of the male eye to that of the female is similar to that in *Tabanus*. The male eye exhibits a narrow, lower, small-facetted portion bearing the same complicated pattern as in the eye of the female. The broad, upper, large-facetted portion is usually unicolorous and never banded. This area of the eye is usually of a shining grey or greyish bronze colour, occasionally, e.g., *H. mactans*, with a number of irregularly placed minute dusky spots.

**Haematopota denshami,** Aust. (Pl. XI, fig. 1.)

An abundant species in open grass country in Northern Kavirondo, British East Africa, and in the less forested parts of Uganda. It occurs side by side with *H. similis*, Ric., and *H. unicolor*, Ric. Very large numbers of both sexes of all three species were taken and in spite of the fact that the females all closely resemble one another, the males, as will be seen from the figures (Pl. XI, figs. 1, 2, 3), differ from one another in a remarkable and interesting manner. The ♂ of *H. denshami* is an insect with small dark eyes, a dark thorax, the anterior segments of the abdomen bright ochreous and the posterior ones dusky. The ♂ of *H. similis* is a nearly black insect, with small eyes; while the ♂ of *H. unicolor* is an altogether pale insect with *large* pale eyes.

**Haematopota similis,** Ric. (Pl. XI, fig. 2.)

Like *H. denshami*, this is a very abundant species in open short-grass country in Uganda and the Nyanza Province of British East Africa.

**Haematopota unicolor,** Ric. (Pl. XI, fig. 3.)

The same remarks as regards habits and distribution apply to this species as to *H. similis*, Ric., and *H. denshami*, Aust.

**Haematopota pertinens,** Aust.

A fairly common Nyasaland and Northern Rhodesian species, which occurs principally in short-grass woodland country.

**Haematopota copemani,** Aust.

This species is common in open short-grass country in the Serenje district of Northern Rhodesia, in December.

**Haematopota masseyi,** Aust.

Represented by a single female taken on the Mchinga escarpment, near Mirongo, Upper Luangwa Valley, Northern Rhodesia, in April 1908.

**Haematopota taciturna,** Aust.

Of this northern species I captured two females at Petauke in the Luangwa Valley, Northern Rhodesia, in January 1908. The only other localities from which it has been recorded are Abyssinia and the Anglo-Egyptian Sudan.

**Haematopota fusca,** Aust.

This is a common and widely distributed forest species in Uganda, though I never met with it in very large numbers in any one spot. It also occurs in the forests of the northern portion of the Nyanza Province of British East Africa. Only a single male was captured.

**Haematopota abyssinica,** Surc.

This fly was taken in some numbers in German East Africa, in December, near Iringa and between Iringa and Kilossa. I also captured a single female in British East Africa, near Simba.

**Haematopota tenuis,** Aust.

This small species seems to occur sparingly in the open country of Northern Kavirondo, British East Africa, and of Northern Uganda. There are only two females in my collection, one taken near Mumias, in June, and the other near the north-east shore of Lake Kioga, in August.

**Haematopota nociva,** Aust.

A few individuals of this species were taken on the Upper Shire and near the southern shores of Lake Nyasa in February 1910.

**Haematopota insidiatrix,** Aust.

A small series of this insect was taken on the Upper Shire and on the southern shores of Lake Nyasa in February 1910, and a single ♀ in the lower Luangwa Valley in January 1905.

**Haematopota noxialis,** Aust.

This species is represented by a single specimen from the Upper Shire River, Nyasaland, taken in February, and by a large series, including a few males, from North and South Kavirondo, British East Africa. It seems to frequent mostly rather open country.

**Haematopota stimulans**, Aust.

This species is represented in my collection only by a single ♀ from the Serenje district of Northern Rhodesia, taken in December. It appears however, judging by the material received by the Research Committee, to be not uncommon to the west and north-west of Lake Nyasa.

**Haematopota mactans**, Aust.

This is a common and widely distributed insect, occurring chiefly in the low ground and main river valleys of Northern Rhodesia, Nyasaland, German East Africa and the coast belt of British East Africa. I managed to capture a number of males in various localities; they were mostly taken drinking at damp sand during the heat of the day.

**Haematopota inornata**, Aust.

A few individuals of this little known species were taken in the Mpanga Forest, Toro, Western Uganda, in November 1911.

**Haematopota alluaudi**, Surc.

Very large numbers of this fly, including what appears to be a great range of colour variations, were swarming in the forests on Mt. Kenya and the Aberdare range in February and March 1911.

**Haematopota distincta**, Ric.

This species, which has hitherto been recorded only from Nyasaland, was taken in several localities in German East Africa and also on the top of the Aberdare range in British East Africa, at an elevation of nearly 10,000 ft. It is worthy of note that it occurred in rather open moorland country at the top of the mountain, whilst *H. alluaudi* swarmed near by in the forest, but not outside it. A single ♂ of this species was taken.

**Haematopota hirta**, Ric. (Pl. XI, fig. 4.)

Though not strictly a forest species, this insect occurs chiefly in grassy clearings, papyrus swamps, etc., in the neighbourhood of forest. It is common both in British East Africa and Uganda. The males, which are remarkably hairy little insects, occasionally occur in very large numbers. Thus, on a small marsh on the Kikuyu Escarpment in two days 91 males, besides a few females, were taken.

**Haematopota furva**, Aust.* (Pl. XI, fig. 7.)

This species swarms all over the forested areas in Uganda and British East Africa, coming nearly as far east as Nairobi. The males are not easy to locate and only a few were obtained.

**Haematopota ugandae**, Ric.

This is a common forest species throughout Southern Uganda and the Nyanza Province of British East Africa.

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* *See below*, p. 334.

**Haematopota vittata**, Lw.

Though never very abundant and often extremely local, this species appears to have a very wide distribution over Eastern Africa, particularly in the more well wooded valleys.

**Haematopota neavei**, Aust.* (Pl. X, fig. 9.)

No less than 67 ♀ and 1 ♂ of this striking species were taken in the Tero Forest, South-East Buddu, Uganda, between 26th and 30th September 1911. Though so abundant in this spot, it was local even there and I never met with it elsewhere.

**Haematopota decora**, Walk.

Widely distributed over Eastern Africa. It seems to occur principally in low-lying river valleys in moderately well wooded country. A few males were taken during the month of September at damp sand in dried-up river beds in the Luangwa Valley, Northern Rhodesia, and near the west shores of Lake Nyasa, in October.

**Haematopota brucei**, Aust.

Of this striking species, hitherto known only from the unique type, I was fortunate in obtaining two females in the Mabira Forest, Uganda, in July 1911. I have however no reason to suppose that it is really scarce, though its season is probably a very short one.

**Haematopota brunnescens**, Ric.

This is a common insect all over Uganda and the Nyanza Province of British East Africa. There is also a single specimen in the National Collection taken by Captain R. Crawshay and labelled Nyasaland, but until this is confirmed by further specimens it would seem best to omit this from the list of Nyasaland species. *H. brunnescens* occurs in some variety of country. It is often abundant in the papyrus swamps in Uganda, especially those bordered by patches of forest.

## Genus Tabanus, L.

I have already given some account of the seasonal prevalence of the flies of this genus. Their range is very wide, and it is not very easy to generalise about their habitats, but they are on the whole decidedly more abundant in river valleys, particularly at low elevations, than elsewhere. In British East Africa they are the dominant representatives of the family on the low ground, while *Haematopota* are more dominant at the higher levels. Many species of *Tabanus* also occur in plateau country of moderate elevation, at about 4,000 feet, notably in Northern Rhodesia. At greater elevations, especially in heavily forested country, the flies of this genus are poorly represented, though a few species are peculiar to such localities, such as T. *ruwenzorii*, Ric., from the Ruwenzori range, and the recently described *T. canofasciatus*, Aust., from Mt. Kenya and the neighbouring Aberdare range. These two species occur in dense forest up to at least 6,000 feet above sea-level. *Tabanus africanus*, *T. fasciatus*, and their

* *See below*, p. 336.

allies seem to be most usually found in the neighbourhood of large bodies of water, on the larger rivers, the shores of lakes, etc.

The male *Tabanus* is not nearly such a sluggish insect as that of *Haematopota* or *Chrysops*. They are usually very wary, especially when drinking at damp sand in hot sun, and it requires a sharp eye and a long-handled net to capture them.

The eyes of the majority of species are very striking objects in life. Those of the male consist of two portions, as described already in many other genera of TABANIDAE :—(1) a lower portion, composed of small facets, which also extends as a very narrow line round the whole upper margin of the eye, this small-facetted area being, in my experience, invariably of the same colour as the whole eye in the female of the same species ; (2) an upper portion, formed of large facets, which is usually of a different colour or pattern.

The African species of the genus *Tabanus* may be roughly classified by their eyes. Thus, there are two groups with translucent spotted eyes. The first of these comprises only *T. maculatissimus* and *T. irroratus*. The second includes *T. ditaeniatus* and its allies. These groups both exhibit the exceptional conditions in which there is no difference in colour (at least, in the males of those species which are known) between the upper and lower portions of the male eye, though there is sometimes a difference in the size of the spots in the two areas. It should be noted that the translucent eyes of these insects nearly always turn to a more or less opaque dusky colour immediately after death.

The species which have unicolorous green or bluish-green eyes in the female, such as *T. africanus*, *T. thoracinus*, *T. par*, etc., have also the upper part of the male eye unbanded and usually of a bronze or golden colour. Other species which have a dusky unicolorous eye in the female, such as *T. coniformis*, *T. crocodilinus*, *T. sandersoni* and *T. leucostomus*, have the upper part of the male eye of various shades of shining grey or greyish bronze.

A very important group, including *T. taeniola* and the many species allied to it, have a unicolorous dark eye in the female, while the upper portion of the male eye is grey or sometimes nearly white, with a distinct dusky band across both eyes, which in some species is much broader at the junction of the eyes than at the outer margins, and has the form of a somewhat elongate lozenge. The shape or development of this band is of no diagnostic value, as it varies a good deal in individuals of the same species, and is occasionally evanescent.

Another group of rather small, black and white species, such as *T. gratus*, *T. sharpei*, *T. velutinus*, etc., have the eyes brilliantly banded with crimson and green or blue in both sexes. In these cases, in the upper portion of the male eye the bands are represented, but are much less brilliant and less clearly defined than in the lower portion or in the whole of the female eye.

A smaller group of rather similar black and white insects, including *T. atrimanus* and *T. variabilis*, or species nearly allied to them, have dusky, unbanded eyes in both sexes, the two portions of the male eye being of the same colour. In the case of these species also the male eyes are relatively smaller than in the foregoing group.

The recently described *T. pertinens*, Aust., stands by itself, in my experience, in having a combination of bands and spots in its eyes.

**Tabanus fasciatus niloticus,** Aust.

Fairly common throughout Uganda and the Nyanza Province of British East Africa. Some of the individuals from Lake Edward and the Semliki Valley seem to be somewhat intermediate between *T. fasciatus niloticus* and the western type-form. This species has a powerful flight, and I once took a specimen on board-ship in the middle of the Kavirondo Gulf, some miles from land. The eyes of the female are a beautiful deep green colour. In the males, of which I obtained a small series, the lower small-facetted portion of the eyes resembles that of the female, while the upper large-facetted area is a greyish bronze.

**Tabanus brucei,** Ric.

This fine species is represented in the collection from the region under discussion by a single female from the valley of the Chambezi River, Northern Rhodesia, April 1908. This insect is common in the principal river valleys of Katanga, in the southern Congo Free State, where it has apparently at least two broods during the year: one in October, at the beginning of the rains, and another about April, at the end of the wet season. The eyes of the female are of a deep green colour. The male is not known.

**Tabanus africanus,** Gray.

This species occurs over a very wide area in Eastern Africa, but I have never seen it remarkably abundant in any one place. It is usually found on fairly low ground and particularly in the neighbourhood of large rivers or lakes. I do not recollect ever seeing it near small bodies of water. The males are very scarce; I captured only five individuals, three on the Chitala stream, near Domira Bay, Nyasaland, in October 1910, and two near Lake Kioga, Uganda, in August 1911. The female eye is green, and the male eye green below and golden bronze above.

**Tabanus maculatissimus,** Macq.

This very striking fly is widely distributed in Northern Rhodesia, Nyasaland and German East Africa, but is never plentiful in any one place. In the lower Luangwa Valley, Northern Rhodesia, in September 1910, I captured four males and two females, and the following month in Nyasaland, near Domira Bay, two males and one female; in German Territory, to the north of Lake Nyasa, in November and December, five more females. The male is strikingly different in colouring from the female as may be seen from a comparison of the figure (Pl. X, fig. 1) with that of the female in Mr. Austen's book.* The eyes of both sexes are vitreous, with numerous small black spots.

**Tabanus biguttatus,** Wied.

This striking species occurs all over Eastern Tropical Africa, chiefly on low ground and in the neighbourhood of large bodies of water. The sexes seem to occur in about equal numbers, 76 males and 71 females having been taken during the tour. When on the shores of Lake Mpeketoni, near Kipini, at the mouth of the Tana River, British East Africa, in March 1912, I found a number of these

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* "African Blood-sucking Flies," Pl. VI, fig. 46.

flies laying their eggs on the grasses and reeds at the water's edge. The females were very abundant, the few males seen on this occasion being taken on some small trees about 100 yards from the water. The ♀ eye is black; the ♂ eye black below and silvery grey above.

**Tabanus grandissimus**, Ric.

This species is only represented in my collection by two ♀♀ from the Kalungwisi Valley, Northern Rhodesia, taken in September 1908. It seems to be not uncommon in places on the west shore of Lake Nyasa.

**Tabanus secedens**, Walk.

This is a common fly in Uganda and the Upper Nile Valley, especially in the neighbourhood of forests. The female eye is dark purplish.

**Tabanus socialis**, Walk.

A small series of this characteristically West African species was taken in the Tero Forest, South-East Buddu, Uganda, in September 1911. It was not met with elsewhere. The female eye is dark purplish.

**Tabanus taeniola**, P. de B., and var. **variatus**, Walk.

This is the most abundant and widely distributed species of the genus in Eastern Africa, especially on the lower ground. In all, about 700 males and 670 females were taken of this species and its variety during the tour. In Eastern Africa the var. *variatus* very much out-numbers the typical form. It would appear, however, that on Mombasa Island, judging from specimens collected by Dr. Haran and Dr. W. J. Radford, and at Voi, typical *taeniola* is the common form, but this is quite exceptional for East Africa as a whole.

The eyes of *T. taeniola* and those of the many other species belonging to this group are all very similar. The female eye is usually of a dull purplish colour. In the male eye this colour is replaced in the upper large-facetted portion by a pale greyish ground with a median dusky band. This band varies in width to some extent even in individuals and is occasionally evanescent. In typical specimens it is narrow, though somewhat broader at the junction of the eyes than at the ends. In species such as *T. nyasae*, Ric., and *T. ustus*, Walk., this character is much more pronounced, the band being very broad in the middle and shaped somewhat like an elongate lozenge.

**Tabanus ustus**, Walk.

This insect is a common one before and during the first rains in Northern Rhodesia, Nyasaland and the southern part of German East Africa. The females sometimes occur in very large numbers after the rains have commenced. Between mid-September and the beginning of November in 1910, 221 males and 49 females were collected. The eyes resemble those of *T. taeniola*.

**Tabanus denshami**, Aust.

Both sexes of this species were taken in the Luangwa Valley, N. Rhodesia, in September. Also a single ♀ from near Fort Hall, British East Africa, in February. The eyes resemble those of *T. taeniola*.

**Tabanus nyasae**, Ric.

This seems to be a common insect over a great part of Northern Rhodesia and Western Nyasaland, and my collection contains a very large number of both sexes. Some individuals seem to be scarcely distinguishable from forms of *T. denshami*, Aust. The eyes of both sexes resemble those of *T. taeniola*.

**Tabanus fraternus**, Macq.

A widely distributed species, though nowhere particularly common, so far as my experience goes. Dr. Aders reports, however, that it is plentiful in Zanzibar. It seems to resemble *T. taeniola* in its habits, and the colours of the eyes of both sexes are the same as in that species.

**Tabanus trianguliger**, Aust.

A series of this newly described fly, comprising about 20 females, was taken in the Uhehe and Usangu districts of German East Africa, in November 1910. The female eye is dusky like that of *T. taeniola*.

**Tabanus quadrisignatus**, Ric.

A small series of both sexes of this species was taken in Northern Rhodesia and Nyasaland. The eyes in both sexes resemble those of *T. taeniola*.

**Tabanus distinctus**, Ricardo.

This seems to be a fairly common species throughout North-Eastern Rhodesia, the northern portion of Nyasaland and the part of German East Africa near the northern shore of Lake Nyasa. The eyes of both sexes resemble those of *T. taeniola*, but in the ♂ the ground-colour of the large-facetted area is paler and the dark markings are more distinct.

**Tabanus coniformis**, Ric.

This rather obscure looking insect has a wide distribution in Northern Rhodesia, Nyasaland and German East Africa. The eye of the ♀ is dusky, that of the ♂ dusky below and shining grey above.

**Tabanus sandersoni**, Aust.

Two females were taken in the Ruo Valley, near Chiromo, Nyasaland, in April 1910. The female eyes are dark purplish. I have not seen a living male, but judging by males received by the Entomological Research Committee from Dr. Meredith Sanderson, the large-facetted portion of the male eye would appear to be unbanded and of a purplish bronze colour.

**Tabanus pallidifacies**, Surc.

A small series of eight females of this species was taken on the Tsavo River, British East Africa, in March 1911. They were all captured on the reeds, etc., on the river bank, except one or two which were biting natives bathing in the river. The eyes of the female are dark purplish.

**Tabanus barclayi**, Aust.

Only a single female of this recently described species occurs in my collection, taken in February 1910, in the Upper Shire Valley, Nyasaland. A few

specimens were taken in Central Angoniland and South Nyasa districts about the same time by Drs. A. H. Barclay and J. B. Davey, but the species does not seem to be a common one.

**Tabanus unitaeniatus**, Ric.

A single female was taken on the Lower Zambesi, in February 1904; others in the Luangwa Valley, in January 1905, and on the Upper Shire and the south-west shores of Lake Nyasa, in February and March 1910.

**Tabanus variabilis**, Lw. (Pl. X, fig. 7.)

Fair numbers of this species were captured in various localities. It seems to frequent woodland or moderately open country, not forest. The eyes in both sexes are dusky.

**Tabanus atrimanus**, Lw.

This fly seems to be common and widely distributed all over Eastern Tropical Africa, except Uganda. In my experience, it chiefly frequents well wooded streams. The ♂♂ seem nearly as common as the ♀♀, my collection containing 38 ♂♂ and 46 ♀♀. The eyes of both sexes in life are a dusky purplish.

**Tabanus velutinus**, Surc. (Pl. X, fig. 6.)

A good series of 32 males and 38 females was taken in British East Africa at Masongaleni, Kibwezi, and Makindu, on the Uganda Railway, in April 1911. The insect was evidently just hatching out at that time. The eyes are banded with crimson and green like those of *T. sharpei*.

**Tabanus neavei**, Aust. (Pl. X, fig. 5.)

This is a fairly common forest-haunting species in Uganda, and it also occurs in the forests of North Kavirondo, in the Nyanza Province of British East Africa. My collection contains in all 34 males and 15 females.

**Tabanus sharpei**, Aust.

Though nowhere abundant this species seems to have an extensive range in Northern Rhodesia, Nyasaland and German East Africa, and small numbers of both sexes were taken in various localities in those countries. The female eye is of a deep claret colour, with a median green band. On the male eye the same colouring is reproduced below, but above in the large-facetted area is replaced by an iridescent mauve ground with a dusky band.

**Tabanus wellmanii**, Aust.

Three females were captured on the high plateau south of Lake Tanganyika, Northern Rhodesia, at 4,500 ft., in August 1908, and three more on the Chisinga Plateau, in the Kalungwisi district, in September 1908.

**Tabanus pertinens**, Aust.

This recently described species is a common one in Eastern Africa, chiefly in low-lying river valleys, and fair numbers, in some cases large numbers, were taken in Northern Rhodesia, German and British East Africa. In all, 58 males

and 274 females were obtained. The eyes of this species are remarkably brilliant. The female eye has a ground colour of a clear shining green with a broad transverse crimson band. In the lower part of each eye are two crimson spots. In the male eye the above pattern is reproduced in the lower small-facetted area; the upper portion is also banded with the same colours, but they are much less brilliant and less clearly defined.

**Tabanus diversus,** Ric.

Examples of this species were taken sparingly from various localities in Northern Rhodesia, Nyasaland and German East Africa. Two males captured at the end of September near Fort Jameson, Northern Rhodesia, would seem to be correctly assigned to the females of this species, and this is borne out by the character of the eyes, which in the female are dusky purple. In the case of these males, the small-facetted area has the same dusky purple colour, the large-facetted area being greyish white with a central band of greyish dusky. The absence of green and crimson bands in the lower portion distinguishes these males at once from those of *T. gratus*, which they otherwise somewhat resemble.

**Tabanus gratus,** Lw. (Pl. X, fig. 8.)

This species occurs in river valleys over a very wide area in Eastern Africa, but nowhere in very great abundance. My collection contains 48 males and 17 females in all. The eyes in life are exceedingly beautiful objects. That of the ♀ has a shining green ground-colour, with a border and a central band of shining crimson. The ♂ eye has the lower small-facetted position banded and coloured like the female eye, the large-facetted upper portion being dull greenish grey with a central band of dull crimson.

**Tabanus leucostomus,** Lw. (Pl. X, figs. 3, 4.)

I found this interesting and little known species abundant in Northern Rhodesia and Nyasaland, especially in the low country. I also took a few individuals in similar localities in the coast belt in British East Africa. In this species the males would seem to be more common or at least more easily taken than the females, my collection containing from all sources 144 ♂♂ to 46 ♀♀. It does not seem to bite man very readily. The female eye is black; the male shining black below and dark bluish grey above.

**Tabanus crocodilinus,** Aust.

Represented by a single male taken on a patch of swamp, in October 1910, near Domira Bay, Nyasaland. The ♂ eye has the large facets shining grey and the small facets iridescent greenish. From this it may be inferred with a reasonable degree of probability that the ♀, which I have not myself seen in nature, has eyes of the same iridescent greenish colour.

**Tabanus claritibialis,** Ric.

This appears to be a not uncommon species in the wet season in the Upper Shire Valley and round the southern shores of Lake Nyasa. It has also been received from the mid-Luangwa Valley. The female eyes are dusky and unbanded.

**Tabanus pullulus,** Aust.

Two females of this recently described species were taken on the Upper Shire and on the southern shores of Lake Nyasa, in February and March 1910. It much resembles *T. claritibialis*, to which it is closely allied, both in habits and distribution. The female eyes are dusky and unicolorous.

**Tabanus thoracinus,** P. de B.

A very widely distributed species, occurring in high ground as well as low, and in forest as well as in open country. It is especially abundant in Uganda. The series I obtained comprised 128 males and 202 females. The female eye is a brilliant green (a slightly deeper colour than that of *T. par*); the large-facetted area of the male eye is "old gold," with a greyish iridescence in some lights.

**Tabanus obscuripes,** Ric.

Of this somewhat scarce species I captured 2 males and 2 females near the north-east shore of Lake Bangweolo, between Luwingu and the mouth of the Chambezi River, in October 1908. In November 1910, I took some 10 females in German East Africa, in the Usangu and Usagara districts. The female has dark purplish eyes, *not green* like those of *T. thoracinus*, but the upper area of the male eye is of a golden bronze colour, as in that species.

**Tabanus par,** Walk.

This small species has a wide distribution throughout Tropical Africa. My collection, from all sources, contains 82 males and 48 females. The eye of the ♀ is brilliant emerald green, somewhat paler than that of *T. thoracinus* when compared in life. The upper large-facetted portion of the male eye is of a shining golden colour.

**Tabanus medionotatus,** Aust.

This new species is represented by 6 ♀♀, taken between Luwingu and the mouth of the Chambezi River, near the north-east shores of Lake Bangweolo, Northern Rhodesia, October 1908. Also by a single ♀ from the Upper Kalungwisi Valley, September 1908.

**Tabanus liventipes,** Surc.

This seems to be an uncommon species. It is only represented in my collection by a female collected near Petauke, in the Luangwa Valley, Northern Rhodesia, in January 1905, and by another from the Upper Shire Valley, taken in February 1910. The eyes of the female are green; the male is unknown.

**Tabanus ditaeniatus,** Macq.

Although this species ranges practically throughout Africa, and even as far as India, it seems to be nowhere very abundant in East Africa. It is more common in low country and near the larger rivers or lakes than elsewhere. The ♀ eye is a pale vitreous yellow, with dark spots. In the ♂ the large-facetted area is paler, of a more silvery colour and seems to lack the spots.

**Tabanus fuscipes**, Ric.

This is a common species in the middle of the rainy season in the Shire Valley, Nyasaland, and also in the Luangwa Valley, Northern Rhodesia. The eyes resemble those of *T. ditaeniatus*, Macq.

**Tabanus albipalpus**, Walk.

A few females were taken in the valley of the Kuja River, South Kavirondo, in April 1911, and a single female on the southern slopes of Mount Elgon, in June 1911. The eyes are of the same character as those of *T. ditaeniatus*.

**Tabanus canofasciatus**, Aust.

This interesting species seems to be confined to forestal areas in the neighbourhood of Mount Kenya and the Aberdare Mountains in British East Africa. It occurs up to at least 7,500 feet, in localities where no other species of *Tabanus* are to be found, though certain species of *Haematopota* are plentiful. It bites both man and domestic animals readily. The eyes are dusky.

**Tabanus ruwenzorii**, Ric.

Four females were taken in the Mpanga Forest, Toro, some 15 miles east of the Ruwenzori Range, in November 1911. It is a typically forest species and bites by day, closely resembling *T. canofasciatus* in its habits. The eyes of the female are dusky.

**Tabanus producticornis**, Aust. (Pl. XI, fig. 5.)

A single male and 38 females of this species were captured at Lamu, or on the sea-shore near by, and also on the small Lake Mpeketoni, a short distance inland. This insect would thus appear to breed in salt, or at least brackish, water, as well as in fresh. The female eye is iridescent and of a dark greenish-grey colour. The male eye resembles that of the female below, while the large-facetted area above is of a deep bronze colour.

## Family **Muscidae**.

### Genus Glossina, Wied.

This genus contains the most important, in an economic sense, of the African biting flies, on account of their relation with trypanosomiasis in man and other animals. It becomes necessary therefore to discuss the habits and distribution of each species more fully than in the case of the Tabanidae.

Seven species are at present known from the regions of East Africa under discussion, exclusive of the races or varieties of *G. palpalis* and *G. morsitans* which have been described.

**Glossina morsitans**, Westw.

Before giving an account of the experience of the writer with regard to this important species, reference must first be made to the answers which have been given to a series of questions on the habits of this insect, issued by the Entomological Research Committee in 1910 and 1911.

The majority of the answers come from Government officials, Medical Officers, settlers and others long resident in Nyasaland and Northern Rhodesia. *G. morsitans* is not known to occur in British East Africa and in Uganda appears to be confined to a comparatively limited and little traversed area. But little information is therefore available from this region and, in the case of Uganda, the area of distribution is closely adjacent to, if not actually intermingled with, that of *G. pallidipes*, Aust. It has not, therefore, seemed advisable to refer to the few reports from those regions, owing to the possibility of these two species having been confused.

A large number of gentlemen have been so good as to respond to the series of questions issued by the Committee. Amongst those who have answered at all fully are the following :—

NYASALAND.

Mr. Henry Brown.
Mr. C. A. Cardew.
The Rev. H. A. M. Cox.
Mr. William Edwards.
Mr. D. Fraser.
Mr. R. S. Hynde.
Mr. G. F. Manning.
Mr. L. Murray.
Dr. W. A. Murray.
Dr. J. E. S. Old.
Dr. E. H. Allon Pask.
Mr. J. Percival.
Dr. G. Prentice.
Sir Alfred Sharpe, K.C.M.G.
Dr. H. S. Stannus.

NORTHERN RHODESIA.

Mr. A. L. Barnshaw.
Dr. W. Fisher.
Mr. H. Forsyth.
Mr. H. T. Harrington.
Mr. H. C. Marshall.
Mr. W. A. Rowell.
The Rev. J. van Schalkwijk.
Mr. H. S. Thornicroft.
Mr. R. A. Young.

Although there is considerable conflict of evidence on some points in these answers, some interesting data arise out of them.

There would appear to be a fairly general consensus of opinion that, though it is difficult to define with certainty the limits or character of a fly-area, it is usually a region covered with fairly thin scrub or bush and at a moderately low level. One observer however, Dr. Prentice, says "I have found *morsitans* in the open country, in sparse bush, in dense jungle and in deep dark shade (such as *palpalis* likes) by the water's edge." Others, such as Mr. Barnshaw, state that it never occurs in "msitu," by which he means the patches of dense forest which occur particularly over the Nyasa-Tanganyika plateau and the Awemba country.

Most observers appear to be doubtful whether there is any marked seasonal fluctuation of numbers of the fly. A large majority agree that the presence of water is not essential to the well-being of this insect, whilst three gentlemen, Drs. Pask and Murray and Mr. G. F. Manning, refer to the absence of this species from a belt about half a mile wide along the south-west shore of Lake Nyasa, a fact which had already been noticed by several other observers, including the writer.

On the vexed question of the relations of *G. morsitans* with game, there is, as might be expected, much conflict of evidence, more particularly as on this subject opinions are very apt to be somewhat biassed. Six gentlemen are of the opinion that this species is entirely dependent upon the presence of big game. The view of eight others however is precisely the opposite, whilst three are of opinion that the fly is only partially dependent upon the larger mammals. It must be admitted that the majority of the more experienced observers group themselves amongst those who believe that *G. morsitans* can, and indeed does, exist in the absence of the larger mammalia. The importance of this point is increased by the fact that it agrees with the recently published views of men of such great practical experience as Major J. Stevenson Hamilton and Mr. R. B. Woosnam.

There is however a remarkable unanimity of opinion in the answers as to the spread of *G. morsitans* in recent years in Northern Rhodesia and Nyasaland, practically all observers, with the important exception of Sir Alfred Sharpe, agreeing that this has been the case. Some gentlemen associate this spread with the increase and scattering of big game; others, Messrs. Fraser, Manning and van Schalkwijk, with the movements of natives. Mr. Thornicroft notes a special increase along main roads. Amongst the few people who were in the country when the rinderpest swept through it, there is an agreement that the fly disappeared to a large extent about this time. This is an important point in respect of the above-mentioned spread of the insect, since only one observer, Dr. Prentice, even suggests that the fly has now spread to an area where it did not occur previous to the rinderpest. Five gentlemen, Messrs. Brown, Edwards, /H. ~~B~~arrington, Manning and Young, refer to the disappearance or reduction in numbers of the insect with the advent of natives and the consequent clearings in the neighbourhood of villages.

In respect of my own personal experience and observations of *Glossina morsitans*, I am of opinion that among the essential factors which determine the distribution of this species, are a combination of the presence of such vegetation as will provide moderate but not excessive cover, coupled with a hot and moderately or even very dry climate. This, it is true, does not explain the sometimes marked definition of a fly-area without apparent change in the conditions, a point on which we still appear to be as much in the dark as ever. It does however explain to some extent the difficulty of defining the character of the country in which the fly occurs, when extensive regions are considered, since a considerable variation in the two factors of vegetation and climate might produce the required medium. In many parts of Southern Africa the actual amount of cover required is not excessive, though probably a limited amount of trees, bush or at least thin scrub is necessary. Personally, I am of opinion that, at least for the adult fly, long grass itself would provide sufficient cover, but for the fact that this type of country is burnt clear during the dry season practically every year. That *G. morsitans* inhabits open grass country has been denied by many observers, but it must be remembered that the great majority of Europeans do most of their travelling in the bush during the dry season when the grass is burnt. I have on several occasions, particularly in Northern Rhodesia, noted that when the grass is long (not less than four feet) *G. morsitans* is inclined to be more numerous in grassy areas of limited size than in the woodland or bush-covered country

surrounding them. I have more than once seen this species swarming in long grass on plains of some size, from a half to a mile or more from the line of bush at the edge. In such a locality there would probably be a few isolated trees or bush-covered termite mounds, and in some cases these would probably be the sites for the deposition of pupae. When such a locality is burnt clear, especially if there is a high wind and the grass burns fiercely, large numbers of flies are undoubtedly destroyed. The survivors will generally be found on the outskirts of the surrounding timber. Whether this species could exist on plains of great size covered only with long grass is impossible to say, since, so far as I am aware, this type of country does not occur in Tropical Africa. It must be remembered that the presence of long and rank species of grass denote a soil of at least moderate fertility, and long grass would therefore be almost certainly accompanied by more or less timber. In large short-grass plains, such as those to the east of Lake Bangweolo, this fly does not occur, nor from the paucity of the cover would it be expected to do so. *G. morsitans* also appears to avoid the other extreme, viz :—dense forests where the atmosphere is cool and damp.

My experience of this species in the northern part of its distribution, in the upper Nile Valley, has been very limited, but I obtained a few specimens near Masindi Port on the Victoria Nile in December 1911 and also in the valley of the Kafu River near by. It is perhaps of some significance that this is a decidedly drier area than all the southern part of the Uganda Protectorate and it is also about that point that one begins to enter a rather thin bush and woodland country, presenting a great general resemblance to that of Northern Rhodesia and Nyasaland.

*G. morsitans* would appear to have a rather less marked seasonal variation in numbers than some other species of *Glossina*, being usually fairly numerous throughout the year where it does occur. Some observers have considered that the range of this species is much more restricted in the dry season than in the wet. I have not personally noticed this to be very marked in Nyasaland or Northern Rhodesia, except that, as explained above, the fly is driven out of more open areas into shadier bush by the grass fires.

Reference has been made in a recent paper by Dr. Sanderson to the "migratory" habits of this species. The actual evidence on this point however seems to be almost nil, but it is certainly an important question about which we shall know little of value until some definite flight experiments with marked individuals are carried out. There is no doubt that the distance to which this species will follow its victims is much greater than that of *G. palpalis*. Considerable allowance in studying the range of this species must be made for the state of the weather, to which it is very sensitive. It must be remembered that in dull rainy weather, it would be quite easy to go through a patch of country where this fly was numerous and see scarcely a single individual. In this way a quite erroneous impression of its abundance or otherwise might be gained. *G. morsitans* delights in hot sunny weather and is particularly noticeable under such conditions. In the rainy season it seldom bites unless the sun is shining, but given suitable conditions, such as occur for instance in the Luangwa Valley during the last three months of the dry season, this species will be ready to bite from an hour after sunrise until midnight or even later, especially if

there is a moon and little or no wind. When it is most active it would certainly seem to be more attracted by moving men or animals than by stationary ones, as other observers have already pointed out.

The limit of elevation at which *G. morsitans* occurs in Nyasaland would appear to be about 3,000 feet. In Northern Rhodesia I have never met with it myself at over about 4,200 feet, though it is said to have been taken at somewhat greater elevations. This difference may perhaps be accounted for by the fact that Northern Rhodesia has on the whole a somewhat drier climate than Nyasaland.

Compared with most species of *Glossina*, the complete independence of water exhibited by this species is remarkable. In the Luangwa Valley I have seen it swarming, in intensely hot weather, at least five miles from any known water. Indeed, the drier the atmosphere, the greater seems to be the activity of this fly.

With regard to the relations of *G. morsitans* with game I must unhesitatingly group myself with those who consider that the presence or absence of big game is *not* the primary factor in determining the distribution of the fly. That the presence of a large quantity of big game within a *morsitans* area might influence the numbers of the fly by increasing the food supply is probably true, but that the game materially affects the distribution of the insect I do not for one moment believe. The majority of those who hold the opposite view have acquired their experience in Northern Rhodesia and Nyasaland and, as I shall endeavour to show, have probably been misled by peculiar and abnormal circumstances. It is now I think, pretty generally admitted that, north of the Zambezi at any rate, there is no special relation between *G. morsitans* and buffalo. Certainly in this part of Africa their distribution by no means coincides. Where it does so, these animals are certainly very attractive to the fly, probably because they are slow-moving and are usually in herds of some size.

Perhaps the most important point in connection with this insect is the extension in its distribution which is believed to have taken place in Northern Rhodesia and Nyasaland within recent years. There is now a considerable accumulation of evidence, and my own experience is certainly in accordance with it, that a well-marked spreading into apparently new areas has really taken place. I say *apparently* new because, as I have already pointed out,* I believe that the fly is really recovering the ground lost at the time of the rinderpest. By what means the death of large quantities of game could have caused the disappearance of the insect is now impossible to say positively. I think however the suggestion which has been put forward that the blood of the infected animals was in some way noxious to the fly is at least worthy of consideration. It is certainly not easy to understand how the fly could have died of starvation during the rinderpest epidemic since no actual extermination of the game as a whole seems to have taken place. The zebra, for instance, which swarm in the Luangwa Valley, were unaffected, and it is very doubtful if antelopes such as impala, waterbuck, puku and roan, all of which are very common there, were much reduced in numbers. It will also be seen from Major Stevenson Hamilton's interesting account† that a similar disappearance of the fly, which cannot be explained on the ground of

* Bull. Ent. Res. I, p. 306.
† Bull. Ent. Res. II, p. 114.

starvation, took place in the Transvaal. I have been personally acquainted with the Luangwa Valley from time to time during nearly nine years and the one animal which shows an undoubted increase is the greater kudu, which, as is well known, suffered severely from rinderpest.

Under these abnormal conditions *G. morsitans* seems to have extended its range during recent years to areas suitable to its existence and in which it formerly occurred. In these special circumstances I am somewhat inclined to think that the game has been a factor of some importance. It is not unreasonable to conclude that the general scattering of game at the beginning of the rains, from the limited area near water which they have frequented during the dry season, has somewhat accelerated this spread of the fly during recent years. This could not probably have happened but for these special circumstances, in which there were adjacent areas suitable to the fly and unoccupied by it—a state of affairs which would be very improbable under normal conditions. The fly has apparently now nearly, if not quite, recovered all its lost ground, *i.e.*, its present distribution is approximately the same as before the advent of the rinderpest. It will be of extreme importance to note whether *G. morsitans* now spreads into areas which it did not occupy before the rinderpest, *e.g.*, parts of Angoniland where the natives have kept large herds of cattle for several generations: but it seems to me that this is very unlikely. It will thus be seen that it is possible that some of the observers in Nyasaland and Rhodesia have been unintentionally led to exaggerate somewhat the importance of game as a factor in the distribution of *G. morsitans* by the above mentioned circumstances.

With regard to the relations of this species with man, though, as is well known, it bites man readily, I think it is doubtful whether it has any preference for him as compared with other mammals. Indeed it is questionable whether this is true of any species of *Glossina*, with the possible exception of *G. palpalis*. It has often been stated that *G. morsitans* avoids human habitations, though many observations as to the fly entering native villages have been made. This insect, without question, frequently follows bands of natives traversing main roads into the heart of villages, but it is doubtful if any but an occasional individual remains there any length of time. I am in complete agreement with the views expressed by Sir Alfred Sharpe and others that it is the cleared and cultivated area that usually surrounds native villages which is the deterrent and not the actual human habitations or their accompaniments.

It would therefore seem that this species is only to be exterminated by extensive occupation and cultivation by human beings of the area it occupies. This area must be *kept* cultivated, as it seems probable that not only *G. morsitans* but *G. pallidipes* will return to land where the bush has been allowed to grow up again. Measures for clearing the bush and thus removing the natural cover, as is being done in the case of *G. palpalis*, would seem impracticable. The habitat of the insect is so different and its range usually so much wider, that a road, for instance, through a fly-belt, to be efficiently cleared, would have to be perhaps as much as a mile wide. Possibly something might be done in this direction by imitating the condition surrounding native villages and planting extensive strips of crops, such as sweet potatoes or ground-nuts, by the road-side. It would seem probable that such low-growing crops would be a greater

deterrent than maize or millet, but, so far as I am aware, there is no evidence on this point.

In view of the strong probability that this species can feed on a great variety of vertebrate life, the mere destruction of the large game would seem at first sight absurd, unless the said game can be proved to be the *sole* reservoir of a noxious trypanosome. If a serious attempt is to be made to starve out the insect, the only logical step would involve the removal or destruction of *all* such classes of animal life, including man and his domestic animals.

**Glossina pallidipes**, Aust.

This species somewhat resembles *G. morsitans* in its habits, at least as regards the type of country in which it occurs and the conditions under which it feeds, but it would appear not to be so completely independent of water. So far as my experience goes, though not at all confined to river banks, it is always associated with a fairly considerable amount of bush in rather low-lying river valleys; but given sufficient cover, it would no doubt be found a mile or so from water. There would appear to be some ground for thinking that, in British South Africa at any rate, this tsetse has a more marked seasonal prevalence than *G. morsitans*, being much more numerous at the end of the wet season and the months immediately following it than during the dry. It also seems often to occur in far fewer numbers in any one spot than does *G. morsitans*, which, when the conditions are favourable for seeing it, is usually fairly abundant.

As regards distribution, this species occurs mainly in the coast belt, from which it extends up the principal river valleys, especially near the Equator. An important exception to this is its occurrence in some numbers in western and north-western Uganda, particularly in the Semliki Valley, where, considering the essentially Western character of the fauna generally, *G. longipalpis*, Wied., might have been expected to replace it. When on the Victoria Nile, near Masindi Port, in December 1911, I was fortunate in obtaining both *G. pallidipes* and *G. morsitans* in the same locality, which is of some interest, as authentic records of this seem to be very few. Dr. van Someren's statement that both species occur together as far south as Toro would appear to be mistaken, only specimens of *G. pallidipes* having as yet been received by the Entomological Research Committee from that district.

The records of the distribution of this species in Nyasaland are in a very unsatisfactory state, there being apparently no recent data available and no very accurate localities are known for the very few specimens which are said to have been taken in that country. It is, however, not improbable that this species does occur in Southern Nyasaland, particularly near Lake Shirwa and perhaps on the lower Shire.

Authentic records of *G. pallidipes* occurring at over 4,000 feet do not seem to be available. Reports of what may, perhaps, be this species from near Fort Hall, British East Africa, if confirmed, would, however, show that it can exist at considerably greater elevations.

There would seem to be some evidence that this species, like *G. morsitans*, is kept at bay by cultivation.

In many places along the coast belt of British East Africa the natural bush is now overwhelming the many large native plantations which have been deserted, and this species, and also *G. brevipalpis*, are almost certainly increasing and extending their range. I am informed that, in consequence of this, it is now no longer possible to keep cattle in many places where they flourished a generation ago.

**Glossina austeni,** Newst.

I was fortunate in capturing a few specimens of this recently described and remarkable little species. I first took a single female at Voi, British East Africa, on 9th February 1912, and subsequently two individuals of each sex in the Uchweni forest, near Witu, February 25th–27th, in the same Protectorate.

The Entomological Research Committee have also received a single female from the Juba River from Dr. C. L. Chevallier, from whence came the type, and a male, taken on Mombasa Island on November 22nd, 1911, by Dr. W. J. Radford, Senior Medical Officer at Mombasa.

In spite of its small size this species is readily recognisable in life by the bright rufous colour of the upper surface of the abdomen. So marked is this colour, that from a short distance I mistook the first specimen I saw for a small individual of *Tabanus par.*

I have necessarily had only a very limited experience of this species. It occurs in company with *G. pallidipes* and *G. brevipalpis*, though it seems to require more heavily forested country than that in which those species sometimes are found. It would appear to be confined to the coast belt in British East Africa, where it evidently has a fairly wide distribution. It would not be surprising, however, to hear of its existence in the coast belt in German East Africa also. Up to the present it has not been captured at a greater elevation than about 1,500 feet above sea-level.

**Glossina palpalis,** Rob. Desv.

The habits of this species are now so widely known that it is perhaps not necessary to consider them at any length. As I have pointed out before,* the distribution of this tsetse in the main coincides with that of other insects of the tropical West Coast, and it is therefore strictly not an East African species. Since however political boundaries do not concern themselves with faunistic ones, *G. palpalis* occurs in several of the East African countries under consideration, viz. :—part of N.E. Rhodesia within the Congo basin, the basin of Lake Tanganyika, and of the great lakes of Uganda and of the Upper Nile. Everywhere in this region *G. palpalis* is confined to the shadier portions of lake shores or river banks at elevations under 4,000 feet. In other words, the climate is nowhere sufficiently humid to enable it to exist at any appreciable distance from a permanent body of water. I do not know of any authentic record of its occurring at over 4,000 feet, even at the equator, and the further from the equator, the lower the limit seems to be, as might be expected.

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* Journ. of Econ. Biol. IV, pp. 109–114 (1909).

The distribution of this species on the eastern side of the Victoria Nyanza and in the basin of the Upper Nile is interesting, since there would appear to be some evidence that a climatic change, perhaps a change in the water-level, is taking place in these regions with a consequent effect upon the fauna. This is especially noticeable in the region draining into Lake Kioga. Over this area, with the exception of the banks of the main stream of the Nile connecting the Victoria Nyanza and Lake Kioga, the distribution of *G. palpalis* is remarkably discontinuous. The whole of the Kioga basin proper including Mpologoma, Salisbury, Kwania, &c., is now flat country with swampy watercourses, quite unsuitable for this species. Consequently it is confined at the present day to small patches near the low watershed between the Victoria Nyanza and the streams which flow into the Mpologoma swamp, and again at the foot of Mount Elgon. It also occurs in one or two small patches on the north shore of Lake Kioga itself. The extremely sporadic character of this distribution appears to point to a former time when the nature of the water system was different and the insect occurred almost continuously throughout it.

On the Victoria Nile itself, below Lake Kioga, the fly ceases approximately at a point a little above the marked right-angled bend near Masindi Port. The banks of the river near this point are of great interest as the cover is limited and the climate relatively dry. *G. palpalis* does not occur here in any great numbers and certainly gives the impression of only surviving under difficulties. It is under such conditions as this that the extensive clearing operations which are there being carried out by the Uganda Government would seem to give exceptional promise of success.

The case with regard to the eastern shores and islands of the Victoria Nyanza, which are in the British East Africa Protectorate, is somewhat different. Here again the climate is rather drier than that of Uganda proper, and the amount of forest and bush on the lake shore and on the banks of many of the rivers is comparatively scanty. *G. palpalis* is present for the most part only in small numbers and usually in very limited patches, except on some of the larger rivers such as the Kuja. This region has no doubt always been considerably drier than Uganda proper, on account of the high ground of the Kisii and Sotik countries, immediately to the east of it, intercepting most of the rain. This dryness appears however to have been increased by the action of man within the last few generations. Since the Nilotic Jaluo or Kavirondo invaded the lower part of the country near the Lake shore, the indigenous agricultural Bantu races were driven on to higher ground to the east, chiefly to what is now the Kisii country. This region exhibits evident signs of fairly recent deforestation, which is now practically complete. This condition of affairs has had a considerable effect upon the rainfall of the lower-lying country immediately to the west.

The conditions in Northern Kavirondo are somewhat different, since there the high ground to the east is populated by the Nandi, who are mainly a pastoral people, and much of the primeval forest still exists there in consequence. Such deforestation as has occurred has principally been on the lower ground, in the valleys of the Nzoia and Yala rivers. The insect fauna of this district exhibits evident traces of more or less continuous forest having existed at some former time across Usoga into Uganda proper.

It would then appear that the conditions in North and South Kavirondo, but especially the latter, are not too well suited to *G. palpalis* at the present time. There is a reasonable probability therefore that extensive clearing operations in this region would result in the extinction of the insect.

One point in respect of clearing operations is of interest, namely, that this and probably all other species of *Glossina* habitually *live very near the ground* and probably never settle more than a few feet above it. Hodges and others have demonstrated that clearing operations need not involve the removal of large trees with clean trunks free from low-growing branches. It seems to be the low growth of shrubs, etc., which provides the necessary cover for *G. palpalis*, and this will probably be found true for all species of *Glossina*.

**Glossina brevipalpis,** Newst.

This species seems to be, partially at least, dependent on the presence of water or a moderate degree of atmospheric humidity. It is therefore only found in river valleys and amongst a considerable amount of cover and shade, much more than would be necessary for *G. pallidipes*, but less than for *G. palpalis*. In the height of the dry season it seems to be found only in the immediate proximity of water or cool and damp river beds. It prefers comparatively low country, and I do not know any record of its occurrence at much over 3,000 feet.*

This tsetse feeds for the most part in the early morning and late evening and has, I think, a decided preference for animals as against man. Dr. Sanderson informs me that in the Wankonde country, Northern Nyasaland, he has seen *G. brevipalpis* in native huts. This is however explained by the fact that in that country the natives keep their cattle in their living houses.

The evidence as to whether this species is a carrier of trypanosomiasis is at present very conflicting. It must be remembered that it frequently occurs in company with *G. pallidipes* on the east coast of Africa or with *G. morsitans* in Nyasaland and Northern Rhodesia. On the other hand where it is the only known species of *Glossina*, as in the country to the north and north-west of Lake Nyasa, which is full of cattle, there is no definite evidence of trypanosomiasis among the stock.

**Glossina longipennis,** Corti.

This is a desert-haunting species, confined, so far as at present known, to North-Eastern Africa. It is widely spread over the lower-lying and drier regions to the east and north in the British East Africa Protectorate and will very probably be found extending into the Uganda Protectorate in the country to the south-west and west of Lake Rudolph. It appears to be absent from the sea-coast, where the climate is probably too humid for it. It would seem to be entirely independent of water, and indeed rather to avoid it. I found it most striking, when travelling from station to station on the railway between Voi and Makindu, to find numbers of this species in the dry, semi-desert, thorn-scrub

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* In Austen's "Handbook of the Tsetse-flies," p. 104, the elevation of the Tsavo R. on the Uganda Railway (where this species and *G. longipennis* occur) is given in error as 6,000 feet; this should be about 1,500 feet.

country between the rivers, while on the river banks it was replaced by *G. brevipalpis*.

Like the other large species of *Glossina* it is chiefly on the wing and inclined to feed in the early morning and late evening. It is probably the species which most frequently enters the railway carriages on the Uganda Railway at night, that being the time when the principal trains traverse the region between Voi and Makindu.

**Glossina fusca**, Walk.

This West African species of tsetse enters the region under discussion only on the western boundaries of Uganda. It is not uncommon in the forests of Toro and the Semliki Valley, and is also reported from the Budongo forest, Unyoro, though I did not meet with it there myself. From a limited experience of this insect it would appear to be essentially a dense forest, rather than a riverine, species, and evidently delights in very deep shade. Though occurring in many places with *Glossina palpalis*, the distribution of the two species is by no means coincident, since *G. fusca* seems to be able to exist at considerably greater elevations and in much cooler localities. In Uganda the limit for this species seems to be about 4,500 feet, as compared with rather under 4,000 feet for *G. palpalis* in the same region. It is of course also numerous at much lower elevations, *e.g.*, the forested portions of the Semliki Valley at under 2,500 feet.

It seems to feed principally in the early morning and late evening and shows a decided preference for animals, as compared with man.

The above notes on the habits of the East African species of *Glossina* may perhaps best be summarised by the following classification according to environment :—

A. Requiring a great degree of atmospheric humidity :—
 A. 1. Requiring a high temperature. *G. palpalis*, R. D.
 A. 2. Not requiring a high temperature. *G. fusca*, Walk.

B. Requiring only a moderate degree of humidity :—
 B. 1. Requiring comparatively little cover. *G. pallidipes*, Aust.
 B. 2. Requiring fairly heavy timber and bush. *G. brevipalpis*, Newst.
 B. 3. Requiring more or less dense forest. *G. austeni*, Newst.

C. Independent of water and most active in a dry atmosphere. *G. morsitans*, Westw., and *G. longipennis*, Corti.

The three large species, *G. brevipalpis*, *G. longipennis* and *G. fusca*, may also be separated from the others by their being mainly crepuscular or nocturnal in their habits, instead of being most active in sunshine.

## Genus Stomoxys, Geoffr.

The flies of this genus are, after *Glossina*, the principal biting flies in Africa belonging to the Muscidae. In my experience, they only exceptionally bite man, exhibiting a marked preference for other animals, particularly domestic ones. They are common nearly all over Eastern Africa in the neighbourhood of townships and human habitations where any appreciable number of domestic animals are kept. Though I have exceptionally taken the flies of this genus in

large numbers on freshly killed game, they are not much in evidence out in the bush. They seem most active in bright sunlight.

### Genus Lyperosia, Rond.

I only met with these insects in Western Uganda. They were seen in large numbers on freshly killed eland, waterbuck, kob and wart-hog in various localities in Ankole and the valley of the Semliki. They would appear rarely, if ever, to attack man.

### Genus Auchmeromyia, Br. and Berg.

These flies attack man only in their larval state. They are widely known as "floor maggots" and *A. luteola*, F., (and perhaps other species) occurs in the more neglected huts in native villages throughout Tropical Africa. The adult flies are sometimes to be seen on the walls of native huts, and frequently enter a tent when it is pitched near a village.

### Genus Cordylobia, Grünb.

The flies of this genus also attack man in the larval state by burrowing into the skin and producing a painful boil. Dogs also suffer very badly in some places from this cause, and I have seen one instance in the case of a rat, probably some species of *Tatera*. Many instances in human beings would seem to preclude the possibility of the eggs having been laid direct on the skin by the parent fly, and in these cases they have probably been deposited on clothing when put out to dry.

The commonest species is *C. anthropophaga*, Grünb, and this seems to be more abundant in Northern Rhodesia and Nyasaland than to the north. A few adults of the recently described *C. praegrandis*, Aust., were taken in Northern Rhodesia, Nyasaland and German East Africa, in the same circumstances as *Auchmeromyia luteola*.

## Family **Hippoboscidae.**

The curious flies of this family are widely distributed in Tropical Africa. They are not very easy to collect in any number, at least in the case of the winged forms, on account of their habit of leaving the body of their host immediately after death. If a large animal, such as an antelope, suspected of having these parasites, be shot, the body should be approached quietly, and if no disturbance is made, several of the flies can usually be netted; but they will be driven off at once if numbers of natives are allowed to rush up to the carcase and stand round it, as is their usual habit. The species that frequent birds are often very difficult to capture, as the flies are extremely active, and seldom seen until in the act of flying away. I have often noticed that the best chance of taking the flies arises when the carcase of the shot bird has fallen into water, and the insects then become entangled in the wet feathers.

The following is a brief list of the species taken on my last tour, not including two or three not yet identified.

### Genus Hippobosca, L.

**Hippobosca hirsuta,** Aust.

Two males from the plains north-east of Lake Edward, Uganda, 16th October 1911, on a waterbuck (*Cobus defassa*). One of these was biting a native after having escaped.

**Hippobosca hirsuta** var. **neavei,** Aust.

Eight males and four females were taken in the upper and mid Luangwa Valley, North Eastern Rhodesia, in August 1911, all on waterbuck (*Cobus ellipsiprymnus*). Two males were also obtained on the Lofu River, south of Lake Tanganyika, in August 1908, on a puku (*Cobus vardoni*).

**Hippobosca capensis,** Olf.

A few individuals of this species were taken on natives in the valley of the Ruaha River, German East Africa, in December 1910, and also on dogs at Voi, British East Africa, in February 1912. It is specially associated with Canidae and Felidae.

**Hippobosca struthionis,** Jans.

A good series of this species was taken on a wild ostrich, which was shot for the purpose, near Gimba, British East Africa, in April 1911. A single specimen was also captured on a native in the same neighbourhood.

### Genus Echestypus, Speiser.

**Echestypus paradoxus,** Newst.

This species seems to be a common parasite on Tragelaphine antelopes over a wide area. I found it on a bushbuck at Msoro's, 50 miles west of Fort Jameson, and also on greater kudu, 35 miles east of Fort Jameson, North East Rhodesia, in September 1910; in Nyasaland, on bushbuck, near Kota Kota, in November 1910; in British East Africa, on lesser kudu, near Makindu, in April 1911.

### Genus Olfersia, Leach.

**Olfersia ardeae,** Macq.

Two individuals of this species were taken on the Goliath Heron (*Ardea goliath*), near Kota Kota, Nyasaland, in October 1910.

### Genus Lynchia, Weyenb.

**Lynchia maura,** Big.

A common and almost cosmopolitan parasite of domestic pigeons. I have personally taken it on these birds in Northern Rhodesia, Nyasaland and German East Africa; but it probably occurs all over Eastern Africa.

**Ornithoctona platycera,** Macq.

This is not an uncommon species on Passerine birds over a very wide area. It occurs in my collection from a thrush, *Turdus stormsi*, Hartl., north of Lake Bangweolo, North Eastern Rhodesia, in June 1908, and from a stonechat, *Pratincola torquata*, L.

*Native Names for Blood-sucking Arthropods.*

| — | N. Rhodesia and Nyasaland. | | | | Uganda. | | |
|---|---|---|---|---|---|---|---|
| | Chichawa (Yao). | Chimanganja. | Chiwemba. | Chisenga. | Lusoga. | Luganda. | Lunyoro. |
| Tsetse | Maguo | Maguo | Kasyembe | Kamzembe | Binsukuma | Bivu | Vijuji. |
| *Tabanus*, large | Vipanga | Zipanga | — | Vipanga | Bilumambogo | Bilumambogo | Vilumambogo |
| *Tabanus*, small | Vipanga | Zipanga | — | Vipanga | Binsukuma | — | Vivara. |
| *Haematopota* | Vipanga | Zipanga | — | Vipanga | Binsukuma | — | Mbara. |
| *Simulium* | — | — | — | — | Mbwa | Mbwa | Kachururu. |
| *Culicoides* | — | — | — | — | Bujusiyi | Butugu | — |
| Mosquitos | Uzuzu | — | Imbu | Imbu | Nsiri | Nsiri | Mivu. |
| Larva of *Cordylobia* or *Auchmeromyia*. | Mbisu | — | — | Vikusi | Nyengere | Nyengere | Kihengere. |
| Bed-bug | Gunguni | Msikizi | — | Sania | Biku | Biku | Visuzi. |
| Flea | Utitiri | — | — | — | — | Nkukunyi | Nkukunyi. |
| *Ornithodorus* | Ngufu | Nkufu or Nkufi. | Nkufu | Nkufu | Bibo | Bibo | — |
| Ticks in general. | — | — | — | — | Nkodo | Nkwa | — |

| — | British East Africa. | | | | | |
|---|---|---|---|---|---|---|
| | Kiswahili. | Kikuyu. | Kikamba. | Nandi. | Jaluo (Nilotic Kavirondo). | Jamwa (Bantu Kavirondo). |
| Tsetse | — | — | Chitangua * | Kibjagara (?) | Maugo | Ruuko. |
| *Tabanus*, large | — | Igi or Ngikuvwa. | Nju | Kiptololet. | — | — |
| *Tabanus*, small | — | Mbogo or Zigayi. | Madzunzuma | Kiptololet. | — | — |
| *Haematopota* | — | Mbogo or Zigayi. | Madzunzuma | Sogoriet. | — | — |
| *Simulium* | — | — | — | — | — | — |
| *Culicoides* | — | — | — | — | — | — |
| Mosquitos | Imbu | Lubuyu | Umú | Sogoniat | Suna | Tisuna. |
| Larva of *Cordylobia* or *Auchmeromyia*. | Funsa | Ngagi or Kigago. | — | — | — | — |
| Bed-bug | Kunguni | Gunguni | — | — | — | — |
| Flea | Kiroboto | — | — | — | — | — |
| *Ornithodorus* | Papasi | Ngoha | — | — | — | — |
| Ticks in general. | — | — | — | Karabasiet | Kulundeng | — |

* Signifies "biter of buffalos."

# LOCAL LISTS OF BLOOD-SUCKING ARTHROPODS.

## Northern Rhodesia.

### Order DIPTERA.

#### Family Culicidae.

*Anopheles (Myzomyia) costalis*, Lw.
" " *funesta*, Giles.
" *(Myzorhyncus) mauritianus*, Grp.
*Stegomyia africana*, Theo.
" *fasciata*, F.
*Stegomyia poweri*, Theo.
*Mansonioides uniformis*, Theo.
*Culex pipiens*, var. *zombaensis*, Theo.
" *tigripes*, Grp.
" *univittatus*, Theo.

#### Family Psychodidae.

*Phlebotomus minutus*, Rond.

#### Family Tabanidae.

*Pangonia bubsequa*, Aust.
" *elongata*, Ric.
" *oldii*, Aust.
*Dorcaloemus compactus*, Aust.
" *silverlocki*, Aust.
*Rhinomyza concinna*, Aust.
" *innotata*, Karsch.
" *umbraticola*, Aust.
*Silvius fallax*, Aust.
*Chrysops fuscipennis*, Ric.
" *longicornis*, Macq.
" *wellmanii*, Aust.
*Haematopota copemani*, Aust.
" *divisapex*, Aust.
" *decora*, Walk.
" *furtiva*, Aust.
" *hirsutitarsis*, Aust.
" *insidiatrix*, Aust.
" *mactans*, Aust.
" *masseyi*, Aust.
" *nociva*, Aust.
" *pertinens*, Aust.
" *sanguinaria*, Aust.
" *stimulans*, Aust.
" *taciturna*, Aust.
" *vittata*, Lw.
*Tabanus africanus*, Gray.
" *atrimanus*, Lw.
" *barclayi*, Aust.
" *biguttatus*, Wied.
" *brucei*, Ric.
*Tabanus claritibialis*, Ric.
" *coniformis*, Ric.
" *copemani*, Aust.
" *denshami*, Aust.
" *distinctus*, Ric.
" *disjunctus*, Ric.
" *ditaeniatus*, Macq.
" *diversus*, Ric.
" *fraternus*, Macq.
" *fuscipes*, Ric.
" *grandissimus*, Ric.
" *gratus*, Lw.
" *leucostomus*, Lw.
" *liventipes*, Surc.
" *maculatissimus*, Macq.
" *medionotatus*, Aust.
" *nyasae*, Ric.
" *obscuripes*, Ric.
" *par*, Walk.
" *pertinens*, Aust.
" *pullulus*, Aust.
" *quadrisignatus*, Ric.
" *sharpei*, Aust.
" *septempunctatus*, Ric.
" *taeniola*, P. de B.
" *thoracinus*, P. de B.
" *unitaeniatus*, Ric.
" *ustus*, Walk.
" *variabilis*, Lw.
" *wellmanii*, Aust.
" *xanthomelas*, Aust.

#### Family Muscidae.

*Glossina brevipalpis*, Newst
" *morsitans*, Westw.
" *pallidipes*, Aust.
" *palpalis*, R.D.
*Stomoxys calcitrans*, L.
*Stomoxys nigra*, Macq.
" *brunnipes*, Grünb.
*Auchmeromyia luteola*, F.
*Cordylobia anthropophaga*, Grünb.
" *praegrandis*, Aust.

Family HIPPOBOSCIDAE.

*Hippobosca hirsuta*, Aust. var. *neavei*, Aust.
*Ornithoctonus platycera*, Macq.
*Echestypus paradoxus*, Newst.
*Lynchia maura*, Bigot.

## Order SIPHONAPTERA.

Family SARCOPSYLLIDAE.

*Echidnophaga gallinacea*, Westw.

Family PULICIDAE.

*Ctenocephalus canis*, Curtis.

## Order RHYNCHOTA.

Family CIMICIDAE.

*Cimex rotundatus*, Sign.

## Order ANOPLURA.

Family PEDICULIDAE.

*Phthirius pubis*, L.

Family HAEMATOPINIDAE.

*Haematopinus latus*, Neum.
*Haematopinus aulacodi*, Neum.

## Order ACARI.

Family ARGASIDAE.

*Ornithodorus moubata*, Murray.

Family IXODIDAE.

*Amblyomma marmoreum*, Koch.
" *petersi*, Karsch.
" *variegatum*, F.
*Boophilus decoloratus*, Koch.
*Haemaphysalis leachi*, Aud.
*Hyalomma aegyptium*, L.
*Rhipicephalus appendiculatus*, Neum.
" *capensis*, Koch.
" *evertsi*, Neum.
" *neavei*, Warb.
" *nitens*, Neum.
" *sanguineus*, Latr.
" *simus*, Koch.

# Nyasaland.

## Order DIPTERA.

Family CHIRONOMIDAE.

*Ceratopogon sp.*

Family CULICIDAE.

*Anopheles (Myzomyia) costalis*, Lw.
" " *funesta*, Giles.
" " *longipalpis*, Theo.
" " *marshalli*, Theo.
" *(Myzorhynchus) mauritianus*, Grp.
*Banksinella luteolateralis*, Theo.
*Culex duttoni*, Theo.
" *guiarti*, Blanch.
" *insignis*, Carter.
" *invidiosus*, Theo.
" *pipiens*, L. var. *zombaensis*, Theo.
" *quasigelidus*, Theo.
" *stoehri*, Theo.
" *univittatus*, Theo.
*Ingramia uniformis*, Theo.
*Mansonioides mediolineata*, Theo.
" *uniformis*, Theo.
*Mucidus mucidus*, Karsch.
*Ochlerotatus argenteopunctatus*, Theo.
" *cumminsi*, Theo.
" *marshalli*, Theo.
" *nigeriensis*, Theo.
" *quasiunivittatus*, Theo.
*Taeniorhynchus metallicus*, Theo.
*Toxorhynchites brevipalpis*, Theo.
*Stegomyia fasciata*, F.
" *simpsoni*, Theo.

### Family Psychodidae.

*Phlebotomus minutus*, Rond.

### Family Simuliidae.

*Simulium damnosum*, Theo.
*Simulium neireti*, Roub.

### Family Tabanidae.

*Cadicera flavicoma*, Aust.
" ~~*nigrescens*, Ric.~~ bitaenia Lw.
" *obscura*, Ric.
*Pangonia bubsequa*, Aust.
" *fodiens*, Aust.
" *oldii*, Aust.
*Dorcaloemus compactus*, Aust.
" *bicolor*, Aust.
*Rhinomyza concinna*, Aust.
" *innotata*, Karsch.
*Chrysops distinctipennis*, Aust.
" *fuscipennis*, Ric.
" *longicornis*, Macq.
" *magnifica*, Aust. var. *inornata*, Aust.
*Holcoceria nobilis*, Grünb.
*Haematopota abyssinica*, Surc.
" *decora*, Walk.
" *distincta*, Ric.
" *furtiva*, Aust.
" *insatiabilis*, Aust.
" *insidiatrix*, Aust.
" *longa*, Ric.
" *mactans*, Aust.
" *malefica*, Aust.
" *nocens*, Aust.
" *nociva*, Aust.
" *noxialis*, Aust.
" *pellucida*, Surc.
" *pertinens*, Aust.
" *sanguinaria*, Aust.
" *stimulans*, Aust.
" *vittata*, Lw.
*Tabanus africanus*, Gray.
*Tabanus atrimanus*, Lw.
" *barclayi*, Aust.
" *biguttatus*, Wied.
" *claritibialis*, Ric.
" *coniformis*, Ric.
" *copemani*, Aust.
" *crocodilinus*, Aust.
" *denshami*, Aust.
" *distinctus*, Ric.
" *ditaeniatus*, Macq.
" *diversus*, Ric.
" *fraternus*, Macq.
" *fuscipes*, Ric.
" *grandissimus*, Ric.
" *gratus*, Lw.
" *laverani*, Surc.
" *leucostomus*, Lw.
" *liventipes*, Surc.
" *maculatissimus*, Macq.
" *nigrostriatus*, Ric.
" *nyasae*, Ric.
" *obscuripes*, Ric.
" *par*, Walk.
" *pertinens*, Aust.
" *pullulus*, Aust.
" *quadrisignatus*, Ric.
" *ruficrus*, P. de B.
" *sandersoni*, Aust.
" *sharpei*, Aust.
" *taeniola*, P. de B.
" *unitaeniatus*, Ric.
" *ustus*, Walk.
" *xanthomelas*, Aust.

### Family Muscidae.

*Glossina brevipalpis*, Newst.
" *morsitans*, West.
" *pallidipes*, Aust.
*Stomoxys brunnipes*, Grünb.
" *calcitrans*, L.
" *nigra*, Macq.
*Stomoxys taeniata*, Big.
*Stygeromyia sanguinaria*, Aust.
*Auchmeromyia luteola*, F.
*Cordylobia anthropophaga*, Grünb.
" *praegrandis*, Aust.

### Family Hippoboscidae.

*Hippobosca hirsuta*, Aust. var. *neavei*, Aust.
*Echestypus paradoxus*, Newst.
*Lynchia maura*, Bigot.
*Olfersia ardeae*, Macq.

## Order SIPHONAPTERA.

### Family Sarcopsyllidae.

*Echidnophaga gallinacea*, Westw.
" *larina*, Roths.
*Dermatophilus penetrans*, L.

Family PULICIDAE.

*Chimaeropsylla potis*, Roths.
*Ctenocephalus canis*, Curtis.
„ *felis*, Bouché.
*Moeopsylla sjoestedti*, Roths.
*Xenopsylla aequisetosus*, Endl.
„ *brasiliensis*, Baker.

Order RHYNCHOTA.

Family CIMICIDAE.

*Cimex rotundatus*, Sign.

Order ANOPLURA.

Family PEDICULIDAE.

*Pediculus humanus*, L.
*Phthirius pubis*, L.
*Pedicinus longiceps*, Piag.

Family HAEMATOPINIDAE.

*Haematopinus bufali*, de G.
„ *eurysternus*, Nitzsch.
„ *latus*, Neum.
*Haematopinus peristictus*, Kell. & Paine
*Linognathus forficula*, Kell. & Paine.
„ *vituli*, L.

Order ACARI.

Family ARGASIDAE.

*Ornithodorus moubata*, Murray.

Family IXODIDAE.

*Amblyomma marmoreum*, Koch.
„ *petersi*, Karsch.
„ *tholloni*, Neum.
„ *variegatum*, F.
*Aponomma exornatum*, Koch.
*Boophilus australis*, Fuller.
„ *decoloratus*, Koch.
*Dermacentor rhinocerotis*, De Geer.
*Haemaphysalis hoodi*, Nutt. and Warb.
„ *leachi*, Aud.
*Hyalomma aegyptium*, L.
*Ixodes brunneus*, Koch.
„ *pilosus*, Koch.
„ *tenuirostris*, Neum.
*Rhipicentor bicornis*, Nutt. and Warb.
*Rhipicephalus appendiculatus*, Warb
„ *bursa*, Can. and Fan
„ *capensis*, Koch.
„ *coriaceus*, Nutt. and Warb.
„ *evertsi*, Neum,
„ *falcatus*, Neum.
„ *lunulatus*, Neum.
„ *maculatus*, Neum.
„ *neavei*, Warb.
„ *neavei*, var. *punctatus*, Warb.
„ *sanguineus*, Latr.
„ *sculptus*, Warb.
„ *simus*, Koch.
„ *sulcatus*, Neum.
„ *supertritus*, Neum.

## German East Africa.

Order DIPTERA.

Family CULICIDAE.

*Anopheles (Myzomyia) costalis*, Lw.
„ „ *funesta*, Giles.
„ *(Myzorhynchus) mauritianus*, Grp.
„ *(Nyssorhynchus) pharoensis*, Theo.
*Toxorhynchites brevipalpis*, Theo.
*Stegomyia fasciata*, F.
„ *simpsoni*, Theo.
*Ochlerotatus fascipalpis*, Edw.
„ *leucarthrius*, Speiser.
*Taeniorhynchus fuscopennatus*, Theo.
*Mansonioides uniformis*, Theo.
*Culex pipiens*, L. var. *zombaensis*, Theo
„ *tigripes*, Grp.
*Eretmopodites chrysogaster*, Graham.
„ *quinquevittatus*, Theo.

Family TABANIDAE.

*Cadicera speciosa*, Aust.
*Pangonia elongata*, Ric.
" *mesembrinoides*, Surc.
" *zonata*, Walk.
*Diatomineura aethiopica*, Thunb.
" *distincta*, Ric.
*Rhinomyza innotata*, Karsch.
*Adersia oestroides*, Karsch.
*Chrysops bicolor*, Cordier.
" *longicornis*, Macq.
" *magnifica*, Aust.
*Holcoceria nobilis*, Grünb.
*Haematopota abyssinica*, Surc.
" *albohirta*, Karsch.
" *alluaudi*, Surc.
" *avida*, Speiser.
" *decora*, Walk.
" *distincta*, Ric.
" *hieroglyphica*, Gerst.
" *hirta*, Ric.
" *imbrium*, Wied.
" *mactans*, Aust.
" *maculiplena*, Karsch.
" *vittata*, Lw.
*Parhaematopota cognata*, Grünb.
*Tabanus africanus*, Gray.
*Tabanus amblychromus*, Speiser.
" *atrimanus*, Lw.
" *biguttatus*, Wied.
" *conifornis*, Ric.
" *distinctus*, Ric.
" *ditaeniatus*, Macq.
" *diversus*, Ric.
" *fraternus*, Macq.
" *gratus*, Lw.
" *imbecillus*, Karsch.
" *impurus*, Karsch.
" *latipes*, Macq.
" *maculatissimus*, Macq.
" *obscuripes*, Ric.
" *par*, Walk.
" *pertinens*, Aust.
" *pullulus*, Aust.
" *quadriguttatus*, Ric.
" *quadrisignatus*, Ric
" *sharpei*, Aust.
" *taeniola*, P. de B.
" *thoracinus*, P. de B.
" *trianguliger*, Aust.
" *ustus*, Walk.
" *variabilis*, Lw.

Family MUSCIDAE.

*Glossina brevipalpis*, Newst.
" *morsitans*, Westw.
" *pallidipes*, Aust.
" *palpalis*, R.D.
" *tachinoides*, Westw. (?)*
*Stomoxys bilineata*, Grünb.
" *brunnipes*, Grünb.
" *calcitrans*, L.
" *korogwensis*, Grünb.
*Stomoxys nigra*, Macq.
" *ochrosoma*, Speiser.
" *taeniata*, Big.
" *varipes*, Bezzi.
*Lyperosia schillingsi*, Grünb.
*Auchmeromyia luteola*, F.
*Cordylobia anthropophaga*, Grünb.
" *praegrandis*, Aust.

Family HIPPOBOSCIDAE.

*Hippobosca capensis*, Olf.
" *struthionis*, Janson.
*Echestypus parvipalpis*, Speiser.
*Lynchia maura*, Bigot.
*Ornithoctona platycera*, Macq.
*Olfersia ardeae*, Macq.
" *pilosa*, Macq.

## Order SIPHONAPTERA.

Family SARCOPSYLLIDAE.

*Dermatophilus penetrans*, L.
*Echidnophaga gallinacea*, Westw.

* The record of this species from German East Africa needs confirmation. It is not impossible that the specimens which were identified as *G. tachinoides* may prove to have been really *G. austeni*, Newst.

Family Pulicidae.

*Ctenocephalus canis*, Curt.
*Moeopsylla sjoestedti*, Roths.
*Ceratophyllus infestus*, Roths.
*Ctenopsyllus aethiopicus*, Roths.

Order ANOPLURA.

Family Pediculidae.

*Pediculus capitis*, de G.

Family Haematopinidae.

*Haematopinus eurysternus*, Nitzsch.
*Haematopinus phacochaeri*, End.

Order ACARI.

Family Ixodidae.

*Amblyomma petersi*, Karsch.
" *variegatum*, F.
*Boophilus australis*, Fuller.
" *decoloratus*, Koch.
*Haemaphysalis leachi*, Aud.
*Rhipicephalus capensis*, Koch.
" *evertsi*, Neum.
" *maculatus*, Neum.

## Zanzibar.

Order DIPTERA.

Family Chironomidae.

*Ceratopogon sp.*

Family Culicidae.

*Anopheles* (*Myzomyia*) *costalis*, Lw.
*Stegomyia fasciata*, F.
*Skusea pembaensis*, Theo.
*Taeniorhynchus fuscopennatus*, Theo.
*Mansonioides uniformis*, Theo.
*Culex tigripes*, Grp.

Family Tabanidae.

*Adersia oestroides*, ~~Aust.~~ Karsch.
*Aegophagamyia pungens*, Aust.
*Chrysops longicornis*, Macq.
*Haematopota decora*, Walk.
*Parhaematopota cognata*, Grünb.
*Tabanus africanus*, Gray.
" *biguttatus*, Wied.
*Tabanus ditaeniatus*, Macq.
" *fraternus*, Macq.
" *gratus*, Lw.
" *par*, Walk.
" *taeniola*, P. de B.
" *thoracinus*, P. de B.

Family Muscidae.

*Stomoxys calcitrans*, L
" *nigra*, Macq.
*Lyperosia minuta*, Bezzi
*Cordylobia anthropophaga*, Grünb.

Family Hippoboscidae.

*Hippobosca capensis*, Olf.
" *maculata*, Leach.
*Ornithoeca podicipis*, Röd.

### Order SIPHONAPTERA.

#### Family PULICIDAE.

*Xenopsylla cheopis*, Roths.

### Order ANOPLURA.

#### Family PEDICULIDAE.

*Pediculus capitis*, de G.
*Pediculus humanus*, L.

### Order ACARI.

#### Family IXODIDAE.

*Amblyomma hebraeum*, Koch.
„ *variegatum*, F.
*Boophilus decoloratus*, Koch.
*Haemaphysalis leachi*, Aud.
*Hyalomma aegyptium*, L.
*Rhipicephalus appendiculatus*, Neum.
„ *evertsi*, Neum.
„ *pulchellus*, Gerst.
„ *sanguineus*, Latr
„ *simus*, Koch.

## British East Africa.

### Order DIPTERA.

#### Family CHIRONOMIDAE.

*Culicoides milnei*, Aust.
*Johannseniella fulvithorax*, Aust.
*Ceratopogon sp.*

#### Family CULICIDAE.

*Anopheles (Myzomyia) cinerea*, Theo.
„ „ *costalis*, Lw.
„ „ *funesta*, Giles.
„ „ *longipalpis*, Theo.
„ „ *marshalli*, Theo.
„ „ *rhodesiensis*, Theo.
„ „ *transvaalensis*, Carter.
„ *(Myzorhynchus) mauritianus*, Grp.
„ *(Nyssorhynchus) christyi*, Theo.
„ „ *natalensis*, H. & H.
„ „ *squamosus*, Theo.
*Banksinella luteolateralis*, Theo.
*Stegomyia fasciata*, F.
„ *poweri*, Theo.
„ *unilineata*, Theo.
*Ochlerotatus cumminsi*, Theo.
„ *dentatus*, Theo.
„ *durbanensis*, Theo.
„ *hirsutus*, Theo.
„ *nigeriensis*, Theo.
„ *ochraceus*, Theo.
„ *quasiunivittatus*, Theo.
*Ochlerotatus wellmani*, Theo.
*Skusea pembaensis*, Theo.
*Taeniorhynclus cristatus*, Theo.
„ *fuscopennatus*, Theo.
„ *metallicus*, Theo.
*Mansonioides uniformis*, Theo.
*Culex annulioris*, Theo.
„ *consimilis*, Newst.
„ *decens*, Theo.
„ *duttoni*, Theo.
„ *insignis*, Carter.
„ *invidiosus*, Theo.
„ *ornatothoracis*, Theo.
„ *pipiens*, L. var. *zombaensis*, Theo.
„ *rima*, Theo.
„ *salisburiensis*, Theo.
„ *simpsoni*, Theo.
„ *stoehri*, Theo.
„ *tigripes*, Grp.
„ *tipuliformis*, Theo.
„ *univittatus*, Theo.
*Uranotaenia alba*, Theo.

#### Family SIMULIIDAE.

*Simulium damnosum*, Theo.
*Simulium neireti*, Roub.

Family TABANIDAE.

*Pangonia comata*, Aust.
" *beckeri*, Bezzi.
" *magrettii*, Bezzi.
" *rüpellii*, Jaen.
" *elongata*, Ric.
*Diatomineura distincta*, Ric.
*Dorcaloemus compactus*, Aust.
" *woosnami*, Aust.
*Rhinomyza perpulcra*, Aust.
*Aegophagamyia pungens*, Aust.
*Chrysops cana*, Aust.
" *ciliaris*, Lw. (?)
" *distinctipennis*, Aust.
" *funebris*, Aust.
" *longicornis*, Macq.
*Haematopota abyssinica*, Surc.
" *alluaudi*, Surc.
" *brunnescens*, Ric.
" *denshami*, Aust.
" *distincta*, Ric.
" *furtiva*, Aust.
" *furva*, Aust.
" *fusca*, Aust.
" *hirta*, Ric.
" *insidiatrix*, Aust.
" *longa*, Ric.
" *mactans*, Aust.
" *noxialis*, Aust.
" *similis*, Ric.
" *tenuis*, Aust.
*Haematopota tumidicornis*, Aust.
" *ugandae*, Ric.
" *unicolor*, Ric.
" *vittata*, Lw.
*Tabanus africanus*, Gray.
" *albipalpus*, Walk.
" *atrimanus*, Lw.
" *biguttatus*, Wied.
" *canofasciatus*, Aust.
" *conspicuus*, Ric.
" *denshami*, Aust.
" *ditaeniatus*, Macq.
" *fasciatus niloticus*, Aust.
" *gratus*, Lw.
" *kingi*, Aust. var. *nigrifeminibus*, Aust.
" *leucostomus*, Lw.
" *morsitans*, Ric.
" *neavei*, Aust.
" *pallidifacies*, Surc.
" *par*, Walk.
" *pertinens*, Aust.
" *producticornis*, Aust.
" *rothschildi*, Surc.
" *sufis*, Jaen.
" *taeniola*, P. de B.
" *thoracinus*, P. de B
" *unitaeniatus*, Ric.
" *variabilis*, Lw.
" *velutinus*, Surc.
" *xanthomelas*, Aust.

Family MUSCIDAE.

*Glossina austeni*, Newst.
" *brevipalpis*, Newst.
" *longipennis*, Corti.
" *pallidipes*, Aust.
" *palpalis*, R.D.
*Stomoxys varipes*, Bezzi.
" *calcitrans*, L.
*Stomoxys nigra*, Macq.
" *taeniata*, Big.
" *brunnipes*, Grünb.
*Lyperosia minuta*, Bezzi.
*Stygeromyia woosnami*, Aust.
*Auchmeromyia luteola*, F.

Family HIPPOBOSCIDAE.

*Hippobosca struthionis*, Janson.
" *maculata*, Leach.
" *camelina*, Leach.
" *capensis*, Olf.
*Echestypus sepiaceus*, Speiser.
" *paradoxus*, Newst.
*Olfersia pilosa*, Macq.

Order SIPHONAPTERA.

Family SARCOPSYLLIDAE.

*Echidnophaga gallinacea*, Westw.
*Echidnophaga larina*, Roths.

Family PULICIDAE.

*Ctenocephalus canis*, Curtis.
*Ctenopsylla ellobius*, Roths.
*Pulex irritans*, L.
*Xenopsylla brasiliensis*, Baker

### Order ACARI.

#### Family Argasidae.

*Argas brumpti*, Neum.
*Ornithodorus moubata*, Murray.
*Ornithodorus savignyi*, Aud.

#### Family Ixodidae.

*Amblyomma gemma*, Dön.
" *marmoreum*, Koch.
" *petersi*, Karsch.
" *variegatum*, F.
*Boophilus decoloratus*, Koch.
*Dermacentor rhinocerotis*, De Geer.
*Haemaphysalis leachi*, Aud.
" *parmata*, Neum.
*Hyalomma aegyptium*, L.
*Ixodes pilosus*, Koch.
" *rasus*, Neum.
*Rhipicephalus appendiculatus*, Neum.
" *armatus*, Poc.
" *evertsi*, Neum.
" *falcatus*, Neum.
" *maculatus*, Neum.
" *neavei*, Warb.
" *pravus*, Dön.
" *pulchellus*, Gerst.
" *sanguineus*, Latr.
" *simus*, Koch.

## Uganda.

### Order DIPTERA.

#### Family Chironomidae.

*Culicoides grahami*, Aust.
" *brucei*, Aust.
" *milnei*, Aust.
*Culicoides distinctipennis*, Aust.
" *neavei*, Aust.

#### Family Culicidae.

*Anopheles (Myzomyia) costalis*, Lw.
" " *funesta*, Giles.
" " *marshalli*, Theo.
" *(Christya) implexus*, Theo.
" *(Myzorhynchus) mauritianus*, Grp.
" *(Nyssorhynchus) pharoensis*, Theo.
*Toxorhynchites brevipalpis*, Theo.
*Mucidus scatophagoides*, Theo.
*Banksinella luteolateralis*, Theo.
*Stegomyia africana*, Theo.
" *apicoargentea*, Theo.
" *fasciata*, F.
" *fraseri*, Edw.
" *luteocephala*, Newst.
" *simpsoni*, Theo.
" *sugens*, Wied.
*Ochlerotatus argenteopunctatus*, Theo.
" *cumminsi*, Theo.
" *domesticus*, Theo.
" *hirsutus*, Theo.
" *minutus*, Theo.
" *nigeriensis*, Theo.
" *quasiunivittatus*, Theo.
*Taeniorhynchus annettii*, Theo.
" *aurites*, Theo.
" *fuscopennatus*, Theo.
" *metallicus*, Theo.
" *microannulatus*, Theo
*Mansonioides uniformis*, Theo
*Culex consimilis*, Newst.
" *decens*, Theo.
" *duttoni*, Theo.
" *grahami*, Theo.
" *guiarti*, Blanch.
" *insignis*, Carter.
" *invidiosus*, Theo.
" *pipiens*, L. var. *zombaensis*, Theo.
" *quasigelidus*, Theo.
" *rima*, Theo.
" *tigripes*, Grp.
*Culiciomyia nebulosa*, Theo.
*Micraëdes inconspicuosus*, Theo.
*Hodgesia sanguinis*, Theo.
*Uranotaenia alboabdominalis*, Theo.
" *bilineata*, Theo.
" *coeruleocephala*, Theo.
" *fusca*, Theo.
" *mashonaensis*, Theo.
" *ornata*, Theo.
" *pallidocephala*, Theo.
*Mimomyia hispida*, Theo.
" *plumosa*, Theo.
" *splendens*, Theo.
*Ingramia nigra*, Theo.
" *uniformis*, Theo.
*Harpagomyia taeniarostris*, Theo.
*Eretmopodites chrysogaster*, Graham.
" *oedipodius*, Graham.

### Family Simuliidae.

*Simulium damnosum*, Theo.

### Family Psychodidae.

*Phlebotomus sp.*

### Family Tabanidae.

*Rhinomyza perpulcra*, Aust.
*Chrysops brucei*, Aust.
„ *centurionis*, Aust.
„ *distinctipennis*, Aust.
„ *funebris*, Aust.
*Hippocentrum versicolor*, Aust.
*Haematopota abyssinica*, Surc.
„ *brucei*, Aust.
„ *brunnescens*, Ric.
„ *decora*, Walk.
„ *denshami*, Aust.
„ *fusca*, Aust.
„ *furva*, Aust.
„ *hirta*, Ric.
„ *inornata*, Aust.
„ *mactans*, Aust.
„ *neavei*, Aust.
„ *similis*, Ric.
„ *tenuis*, Aust.
„ *ugandae*, ~~Aust.~~ Ric.
„ *unicolor*, Ric.
„ *vittata*, Lw.
*Tabanus africanus*, Gray.
„ *albipalpus*, Walk.
*Tabanus biguttatus*, Wied.
„ *brucei*, Aust.
„ *brumpti*, Surc.
„ *crocodilinus*, Aust.
„ *denshami*, Aust.
„ *ditaeniatus*, Macq.
„ *fasciatus niloticus*, Aust.
„ *fuscipes*, Ric.
„ *gratus*, Lw.
„ *irroratus*, Surc.
„ *latipes*, Macq.
„ *neavei*, Aust.
„ *obscurior*, Ric.
„ *par*, Walk.
„ *quadrisignatus*, Ric.
„ *ruficrus*, P. de B.
„ *ruwenzorii*, Ric.
„ *secedens*, Walk.
„ *socialis*, Walk.
„ *taeniola*, P. de B.
„ *thoracinus*, P. de B.
„ *variabilis*, Lw.
„ *xanthomelas*, Aust.

### Family Muscidae.

*Glossina fusca*, Walk.
„ *morsitans*, West.
„ *pallidipes*, Aust.
„ *palpalis*, R.D. (*fuscipes*, Newst.).
*Stomoxys brunnipes*, Grünb.
„ *calcitrans*, L.
„ *nigra*, Macq.
*Stomoxys ochrosoma*, Speiser.
„ *omega*, Newst.
*Lyperosia minuta*, Bezzi.
„ *punctigera*, Aust.
„ *thirouxi*, Roub.
*Auchmeromyia luteola*, F.
*Cordylobia anthropophaga*, Grünb.

### Family Hippoboscidae.

*Hippobosca hirsuta*, Aust.
„ *maculata*, Leach.
*Ornithoctonus platycera*, Macq.
*Olfersia pilosa*, Macq.
„ *dukei*, Aust.
*Echestypus paradoxus*, Newst.

## Order SIPHONAPTERA.

### Family Sarcopsyllidae.

*Echidnophaga larina*, Roths.

### Family Pulicidae.

*Ctenocephalus canis*, Curtis.
„ *felis*, Bouché.
*Ctenopsylla ellobius*, Roths.
*Xenopsylla brasiliensis*, Baker.
„ *cheopis*, Roths.

## Order ANOPLURA.

### Family Pediculidae.

*Pediculus capitis*, de G.

### Family Haematopinidae.

*Haematopinus eurysternus*, Nitzsch.
„ *latus*, Neum.
*Haematopinus peristictus*, Kell. & Paine.
*Linognathus vituli*, L.

## Order ACARI.

### Family Argasidae.

*Ornithodorus moubata*, Murray.

### Family Ixodidae.

*Amblyomma cohaerens*, Dön.
„ *petersi*, Karsch.
„ *tholloni*, Neum.
„ *variegatum*, F.
*Aponomma exornatum*, Koch.
*Boophilus australis*, Fuller.
„ *decoloratus*, Koch.
*Dermacentor circumguttatus*, Neum.
„ *rhinocerotis*, De Geer.
*Haemaphysalis hoodi*, Nutt. and Warb.
„ *leachi*, Aud.
*Rhipicephalus appendiculatus*, Neum.
„ *capensis*, Koch.
„ *dux*, Dön.
„ *evertsi*, Neum.
„ *falcatus*, Neum.
„ *lunulatus*, Neum.
„ *neavei*, Warb.
„ *sanguineus*, Latr.
„ *simus*, Koch.
„ *sulcatus*, Neum.

## EXPLANATION OF PLATE X.

Fig. 1. *Tabanus maculatissimus*, Macq., ♂.
2. „ *irroratus*, Surc., ♀.
3. „ *leucostomus*, Lw., ♂.
4. „ „ ♀.
5. „ *neavei*, Aust., ♂.
6. „ *velutinus*, Surc., ♂.
7. „ *variabilis*, Lw., ♂.
8. „ *gratus*, Lw., ♂.
9. *Haematopota neavei*, Aust., ♂.
10. *Holcoceria nobilis*, Grünb., ♀.

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EAST AFRICAN TABANIDÆ.

## EXPLANATION OF PLATE XI.

Fig. 1. *Haematopota denshami*, Aust., ♂.

2. „ *similis*, Ric., ♂.

3. „ *unicolor*, Ric., ♂.

4. „ *hirta*, Ric., ♂.

5. *Tabanus producticornis*, Aust., ♂.

6. *Chrysops centurionis*, Aust., ♂.

7. *Haematopota furva*, Aust., ♂.

8. *Chrysops distinctipennis*, Aust., ♂.

9. „ *brucei*, Aust., ♂.

10. *Aegophagamyia pungens*, Aust., ♂.


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AFRICAN TABANIDÆ.

# ON A NEW SPECIES OF MITE (*TARSONEMUS*) INJURIOUS TO SUGAR-CANES IN BARBADOS.

By Stanley Hirst.

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Mr. A. D. Michael has already recorded* the presence of mites of the genus *Tarsonemus* upon diseased sugar-cane from Barbados. He states that two species belonging to this genus were present in the material sent to him, and that the larger of the two species was certainly identical with one which Mr. Bancroft found doing serious damage to sugar-cane in Queensland. Mr. Michael proposed the name *Tarsonemus bancrofti* for this larger species. So far as I am aware, no description of this nominal species has been published and I am obliged to rely on Mr. Bancroft's published sketches† for information concerning it. Unfortunately his drawings are not executed in sufficient detail and I am not certain that his mite is the same species as the one which is dealt with in the present note; but as the figures of the Queensland mite differ appreciably from the Barbados specimens, it seems advisable to describe the latter under another name (*T. spinipes*). The species of the genus *Tarsonemus* often resemble one another very closely in structure, and they cannot be recognised with certainty unless a fully detailed account of their principal characters, accompanied by careful drawings, is given. Dr. Bancroft gives drawings of both sexes of his mite. He does not figure any spines on the third leg of the male, but he shows a lobe-shaped expansion, similar to that of *T. spinipes*, on the inner side of the short fourth leg. The hairs of the body are not depicted. According to his drawings, the body of the female resembles that of *T. spinipes* in being very long and narrow, but is apparently much narrower at the anterior end. He represents the two terminal setae of the fourth leg of the female as being both very long and slender, the outer one being seemingly almost as long as the inner. The size of *T. bancrofti* is not stated, nor is the scale of enlargement of the figures given.

I wish to express my thanks to Mr. G. A. K. Marshall, the Scientific Secretary of the Entomological Research Committee, for his kindness in giving me the opportunity of describing this interesting acarus. The specimens were kindly sent by Mr. John R. Bovell, Superintendent of the Local Department of Agriculture, Barbados. It is interesting to note that the species which were mentioned in Mr. Michael's paper twenty-two years ago were also received from Mr. Bovell.

**Tarsonemus spinipes**, sp. n.

♂.—Shape of *body* (fig. 1 *a, b*) very like that of *T. spirifex*, Marchal. *Dorsal surface* apparently furnished with the same number of hairs as in the species just mentioned, but they differ somewhat in size and also in arrangement. Four pairs

* Bull. Royal Gardens, Kew, 1890, pp. 85–86.

† 2nd Annual Report of the Board appointed to inquire into the causes of Diseases affecting Live Stock and Plants; Votes and Proc. of the Legislative Assembly, Queensland, 1877, Vol. III, pp. 1037–1062.

of hairs occur on the upper surface of the "cephalothorax"; the first two pairs are not very long and they are placed closer together than the hairs of the posterior pairs; the hairs of the third pair are very long and fine and those of the fourth are fairly long. "Abdominal" part of body furnished dorsally with three pairs of hairs; the hairs of the first pair being long, but the others considerably shorter. A minute hair is also present on each side of the conical sexual organ at the posterior end of the body.

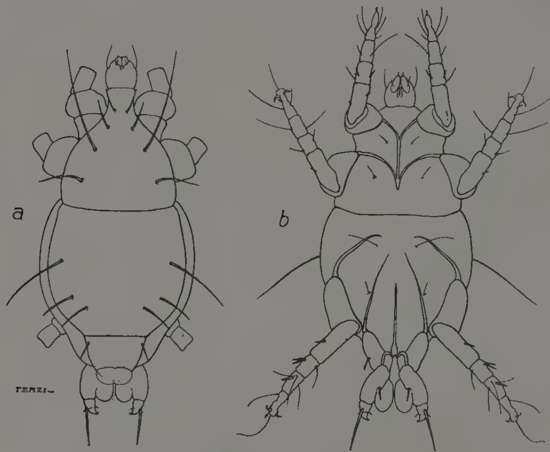


Fig. 1. *Tarsonemus spinipes*, Hirst, ♂;
*a*, dorsal view; *b*, ventral view.

*Capitulum* about as broad as long; on each side it has a long curved hair, the terminal part of which is exceedingly fine. *Palpi* minute and placed on the ventral surface of the capitulum. Each palp has a small hair near the proximal end and another very minute hair at the distal end also.

*Legs*: basal segments of anterior legs much enlarged, as in *T. spirifex*. Anterior legs furnished with hairs and a few minute spines. In addition to hairs, the third leg has several well developed spines on its anterior surface—a slender antero-ventral spine being present on the femur, two strong spines on the patella, and a single strong spine on the tibia. Fourth leg much reduced in length and strongly modified. On the inner side, it has a large, but very thin lobe, and a short, but distinct, ventral spine is situated at the point at which this membranous lobe joins the limb. A strong and fairly long spiniform bristle is present near the claw-like distal end of this leg.*

Length of male ·2 mm.

* The last leg of the male of *T. hominis*, Dahl, is armed with two bristles, which are apparently placed in the same positions as the spine and bristle of this leg in *T. spinipes*. Prof. Dahl does not figure any lobe on the inner side of this leg, but his drawing is based on photographs, and this delicate membranous structure probably would not be shown distinctly in a photograph.

♀.—*Body* very long and narrow (fig. 2); when viewed from above, six segments are visible, but the last one is small. There is only one pair of very long hairs on the body and it is situated on the upper surface of the first segment (cephalothorax). Two pairs of hairs, of moderate length, are present on the second segment, those of the inner pair being stouter than those of the outer. The few hairs which occur on the remaining segments of the body are short and

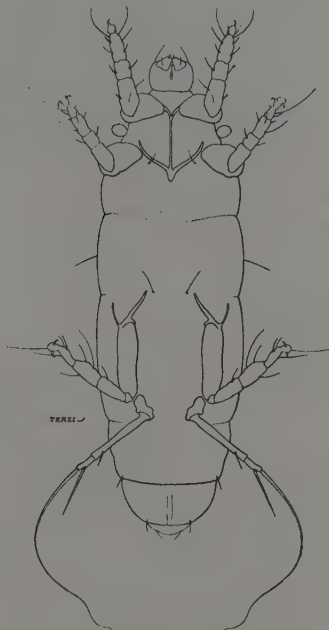

Fig. 2. *Tarsonemus spinipes*, Hirst, ♀, ventral view.

fine. *Legs:* segments of first leg four in number, not including the coxa; second leg apparently with five segments, not including the coxa. Posterior legs very like those of *T. spirifex*; tarsus of third leg somewhat bent. Penultimate segment of fourth leg long and furnished with a spiniform seta of moderate length near the apical end; the last segment of this leg, as usual, has two setae at the end, the outer one being fairly long and the inner one very long and fine.

Length of female ·35 mm.

*Larva:* as is the case in *T. spirifex*, the shape of the body of the male larval form is very different from that of the female larva, a strong constriction being present at a short distance from the posterior end. The size of the larva of this sex is much less than that of the female larva.

This new species of *Tarsonemus* is very closely allied to *T. spirifex*, Marchal—a European species which attacks oats. The male seems to differ from that of *T. spirifex* chiefly in having spines on the third leg, and the female differs principally in shape, its body being long and narrow.

The following note on this sugar-cane mite was made by Mr. W. Nowell, Entomologist to the Local Department of Agriculture, Barbados :—"Causes small red blisters on the surface of the young internodes of sugar-cane while still in the sheathing canes, which are also to some extent affected. Results in a reddish brown corroded appearance of the surface of the cane, especially a streak above the eye."

In the Kew Bulletin for 1890, p. 88, the following method of dealing with canes which are affected by the disease (Red Rust) caused by these *Acari* is recommended. "1. Clean the joints entirely from all trash as carefully as possible. 2. Immerse for 24 hours in water and carbolic acid at temperature to bear the hand,—1 lb. of acid to 50 gallons of water. 3. Make milk of lime,—2 lbs. of lime to 1 gallon of water; immerse the plants in this for a few minutes. 4. Lift out and spread in the sun, turning them over to dry for one day before planting." Infected *dêbris* should be burned.

# NEW AFRICAN TABANIDAE.—Part II.*

By Ernest E. Austen.

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## TABANINAE.

### Genus Tabanus, L.

**Tabanus medionotatus,** sp. n.

♀.—Length (12 specimens) 9·5 to 12 mm.; width of head 3·5 to 4·4 mm.; width of front at vertex just under 0·5 to just under 0·6 mm.; length of wing 7·75 to 9·8 mm.

*Small species, in size and general coloration agreeing with* Tabanus par, *Walk., but distinguishable owing to the presence of a dark, elongate, median blotch on the proximal half or at the base of the dorsal surface of the abdomen; front tarsi dark brown, first and second joints sometimes paler at base.*

*Head:* front, subcallus, and sides of face raw-sienna-coloured † pollinose, face (except sides), jowls, and basioccipital region yellowish-grey pollinose, clothed with cream-buff or ochraceous-buff hair; occiput yellowish olive-grey pollinose; *front* somewhat narrow, inner margins of eyes bordering it converging slightly below, sometimes almost parallel; *frontal callus* raw-umber-coloured, cuneate, its upper extremity produced into a median ridge; *palpi* ochraceous-buff or buff, proximal joint clothed with yellowish hair, terminal joint moderately swollen at base, clothed on outer side with minute, appressed, glistening, buff-yellow hairs, usually mixed with minute, appressed, black hairs; first and second joints of *antennae* ochraceous-buff, clothed above with minute black hairs, third joint ochraceous, tawny-ochraceous, or tawny, expanded portion short and broad, annulate portion sometimes brownish at distal extremity. *Thorax:* dorsum unstriped, ground-colour black, clothed with olivaceous pollen and short yellowish hairs, with which longer blackish hairs are intermixed; humeral calli, swelling in depression at each end of transverse suture, a small area between this swelling and postalar callus on each side, and upper extremity of mesopleurae greyish pinkish-buff, clothed with yellowish hair, which on swelling at each end of transverse suture is mixed with black hair; pectus and pleurae (except upper extremity of mesopleurae) agreeing with dorsum in coloration and pollinose covering, and clothed with pale yellowish hair. *Abdomen* tawny, clothed above and below with minute, appressed, yellowish hairs, which on upper surface are mixed with minute black hairs; upper surface at base with an elongate, greyish clove-brown, median blotch, exhibiting varying degrees of development in different individuals, and when most fully developed extending from base of first segment nearly to hind margin of third; in other specimens the blotch does not quite reach to the middle of the third segment, while in others

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* For Part I *see* Bull. Ent. Res., Vol. III, Part 2, p. 113 (August, 1912).

† For names and illustrations of colours, *see* Ridgway, "A Nomenclature of Colors for Naturalists" (Boston: Little, Brown & Company, 1886).

again it fails to extend so far as the middle of the second segment; in any case the blotch, which is broad and quadrate on the first segment and may be indistinctly interrupted just before reaching the hind margin of this segment, is much narrower on the second segment and narrower still on the third, so that the lateral margins of the blotch are not straight but have an indented appearance; in many specimens the blotch is strongly constricted or even interrupted just before reaching the hind margin of the second segment; in one of the para-types examined, in which the main blotch terminates on the third segment, at a point three-fourths of the length of the segment from the base, there is also a small dark median spot at the base of the fourth tergite. *Wings* nearly hyaline, or faintly tinged with buff on proximal two-thirds; costal cells buff; veins mainly orange-buff, costa darker, distal extremities of veins light mummy-brown; *stigma* ochre-yellow, sometimes but slightly developed. *Squamae* cream-buff. *Halteres:* knobs buff, stalks ochraceous-buff, sometimes paler. *Legs:* front coxae buff, clothed with yellowish pollen and long yellowish hair, middle and hind coxae usually darker, yellowish pollinose and clothed with shorter yellowish hair, front coxae sometimes as dark as pectus; front femora and tibiae, and femora, tibiae, and tarsi of middle and hind legs ochraceous, tips of front tibiae and of joints of middle and hind tarsi dark brown or brownish; third and fourth joints of front tarsi somewhat expanded.

North-Eastern Rhodesia: type and nine para-types from the eastern shores of Lake Bangweolo, between Luwingu and the mouth of the Chambezi River, alt. 3,900 ft., 5–17.x.1908 (*S. A. Neave*); an additional specimen from the Upper Kalungwisi Valley, alt. 4,200 ft., 8.ix.1908 (*S. A. Neave*); another example from the Kasama District, October 1904 (*R. L. Harger*). The type, five of the para-types, and the specimen from the Upper Kalungwisi Valley have generously been presented to the National Collection by Mr. Neave; the remaining para-types are in the Oxford University Museum.

Plastic differences in the case of the new species described above and its near ally *Tabanus par*, Walk., are difficult to discover: as a rule, however, the expanded portion of the third joint of the antennae (measured across its widest part) is, at least in proportion to its length, distinctly broader in *T. medionotatus* than in *T. par*.

**Tabanus neavei,** sp. n. (Plate X, fig. 5).

♂ ♀.—Length, ♂ (15 specimens) 12·25 to 14·25 mm., ♀ (22 specimens) 12·75 to 15 mm.; width of head, ♂ 5 to 5·5 mm., ♀ 4·6 to 5·25 mm.; width of front of ♀ at vertex 0·5 to 0·6 mm.; length of wing, ♂ 11 to 13 mm., ♀ 11·6 to 13 mm.

*Medium-sized, clove-brown or black species, with very conspicuous light-grey or whitish markings on dorsum of thorax and abdomen; thoracic markings including a pair of short admedian longitudinal stripes, which, commencing on front margin, terminate abruptly just beyond transverse suture.—Closely allied to and resembling* T. insignis, *Lw., but distinguished,* inter alia, *by usually more elongate shape of expanded portion of third joint of antennae, by angle on upper margin of latter being less prominent, by more dusky hue of terminal joint of palpi, by markings on tergite of second abdominal segment consisting normally of a large oblique*

*stripe on each side and two small admedian spots close to hind margin (instead of six separate spots), by median spots on third and fourth abdominal tergites being bluntly triangular, instead of nearly semicircular in outline, by whitish hind borders to ventral scutes of third to sixth abdominal segments inclusive being much narrower, and by pale proximal portion of hind tibiae in ♀ being much more restricted in extent.*

*Head:* face, jowls, basioccipital region, and occiput light grey pollinose, frontal triangle in ♂ and subcallus in ♀ sepia-coloured when denuded; face, jowls, and basioccipital region clothed in ♂ with pale yellowish or whitish hair (on sides of face often mixed with brownish hairs), and in ♀ with whitish hair; *front* in ♀ of rather less than moderate width, narrowing somewhat below; *frontal callus* in ♀ dark brown, oblong, extending from eye to eye, its upper extremity emitting a narrow dark brown median ridge or streak, which is visible at least as far as middle of front and often further; vertex in ♀ black and clothed with short, black hairs; when the ♀ is viewed from above, the black vertical area often appears to extend forwards to below the middle of the front, its anterior extremity being separated from the frontal callus by a small silvery-white patch, clothed with appressed, glistening silvery or yellowish hairs; when the ♀ is viewed at a low angle from behind, however, the black area appears confined to the vertex, and the space between it and the frontal callus appears light grey, with its lower portion longitudinally divided by the dark brown median ridge, and its upper two-thirds partially clothed with black hairs; upper two-thirds of *eyes* in ♂ (except hind borders) occupied by a fusiform area (bisected by middle line formed by inner margins of eyes), composed of larger facets than elsewhere; in many dried specimens this fusiform area still appears more or less grey, with a dark lower margin, and a broad dark band (tapering towards the outer margins of the eyes) across the middle;* *palpi* dusky-grey pollinose on outer surface, proximal joint clothed with yellowish or whitish hair, terminal joint in ♂ clothed with blackish hair; terminal joint in ♀ elongate and tapering, paler at base on outer side, where it is clothed with minute, appressed, silvery-white or yellowish hairs, remainder of outer side covered with minute, appressed, black hairs; first and second joints of *antennae* fawn, or isabella-coloured, greyish pollinose, first joint clothed below with whitish hairs, and with minute black hairs above and on its upper distal angle, third joint narrow and elongate in ♂ and at least relatively so in ♀, clove-brown, more or less cinnamon at extreme base. *Thorax:* hind border of main portion of dorsum, including greater part of postalar calli, light grey pollinose, clothed with appressed, glistening, yellowish hair (on postalar calli with whitish or silvery-white hair); admedian longitudinal stripes in ♂ sparsely clothed with fine, yellowish hairs, in ♀ more thickly clothed with short, appressed, glistening, Naples-yellow hairs, which in this sex also partially clothe the interspace between the anterior

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* As regards the markings of the eyes in life, Mr. S. A. Neave, in a field-note attached to a ♂ specimen collected by him at Entebbe, Uganda Protectorate, 5. vii. 1911, writes:—"Eyes banded; blue and crimson below, dusky and grey above"; and Dr. R. Van Someren, in a note on a ♀ caught by him on the Luimi River, Toro, Uganda Protectorate, 22. i. 1911, says that the eye has "a conspicuous, green, horizontal band."

portions of the stripes; swelling in depression at each end of transverse suture greyish-buff or cream-buff, clothed mainly with pale yellowish or ochreous hairs (on posterior extremity with some black hairs); humeral calli greyish pollinose, clothed with whitish hair; dorsum except as already stated clothed with blackish or black hair, which is longer and finer in ♂ than in ♀; pleurae and pectus light grey pollinose (meso-and sternopleurae except hind borders, or at least anteriorly, appearing darker, *i.e.*, mouse-grey), clothed with whitish or yellowish-white hair. *Abdomen:* tergite of first (visible) segment with a light grey pollinose patch at each lateral extremity, scarcely visible from above in ♂; on each side of a median dark area the tergite of this segment, at least in ♂, shows an ill-defined paler, mummy-brown or sepia-coloured area, extending outwards along hind margin towards lateral extremity; in ♀ the paler admedian areas on first segment are sometimes more distinctly greyish pollinose; light grey markings on tergite of second segment as described in diagnosis above, the oblique stripes (occasionally interrupted in ♂) extending from anterior margin on each side of middle line outwards to hind margin, and thence to lateral margins; tergites of third and fourth segments each bearing a large, median, light grey triangle, base of which rests on hind margin; each posterior angle of these tergites is occupied by a light grey transverse mark, which runs inwards along hind margin of segment and diminishes in depth towards median triangle, with which it may or may not be connected; the apex of each median triangle is usually rounded off or truncate before reaching the anterior margin of its segment, the interspace thus formed being generally deeper on the third than on the following segment; posterior angles of tergites of fifth and sixth segments light grey, usually more conspicuously so in ♀ than in ♂; extreme hind margins of fifth and sixth tergites in ♀ sometimes narrowly grey; dorsum, except grey markings, clothed with short or appressed black hair; lateral extremities of tergite of first segment clothed with outstanding whitish hair; posterior angles of five following tergites clothed with glistening whitish or yellowish hair; remaining light grey markings on dorsum clothed with minute, appressed, glistening, pale straw-yellow hair, a median patch of which, simulating the vestige of a triangle, may also be present on posterior half of fifth tergite in ♀; ventral scute of second segment slate-grey, with a more or less distinct, clove-brown or black, quadrate median area, not quite reaching hind margin, but anteriorly sometimes sending off a prolongation to each side; remaining ventral scutes black, with, except in case of last segment, narrow light grey hind borders, clothed with glistening whitish or yellowish-white hair; in case of ventral scutes of penultimate and antepenultimate segments, grey hind borders are much narrower than on preceding segments, and are confined to extreme hind margins; hairy covering of ventral scute of second segment partly blackish, partly whitish, the blackish hair longer and finer in ♂ than in ♀; hair on ventral scutes of following segments, except as already stated, black, on third to fifth segments inclusive shorter and more appressed in ♀ than in ♂. *Wings:* faintly tinged with drab; veins dark brown or brown; *stigma* well-defined and conspicuous, dark mummy-brown. *Squamae* sepia-coloured, borders darker than membrane. *Halteres:* knobs dark sepia-coloured, paler at tips; stalks isabella-coloured, distal extremities darker. *Legs:* coxae grey, front pair and outer surfaces of

middle and hind pairs clothed with yellowish-white, whitish, or pale yellowish hair, posterior extremity of outer surface of hind pair in ♂ usually clothed with dark brown hair ; femora black, clothed partly with black partly with yellowish or whitish hair, posterior surface of front pair in ♀ clothed with whitish hair ; front tibiae in ♂ clove-brown (somewhat paler for a short distance just beyond extreme base), clothed with minute, appressed, black hairs, with which on proximal third minute, glistening, yellowish hairs are sparsely intermingled, outer surface of proximal two-thirds with an irregular fringe of longer and finer blackish hairs ; middle and hind tibiae in ♂ clove-brown at distal extremities, more or less raw-umber-coloured or even paler at and towards their bases, clothed with black hair intermixed proximally with glistening whitish or yellowish hair, inner and outer surfaces of hind tibiae fringed with longer, blackish hair ; front and middle tibiae of ♀ (except tips of both pairs and extreme base of front pair) cream-coloured and clothed with glistening, silvery-white hair, rather less than distal fourth of front tibiae in ♀, a streak extending therefrom towards base on under side, and distal fourth or rather less than distal third of middle tibiae clove-brown and clothed with black hair ; hind tibiae in ♀ cream-coloured at base, then darker, the distal third being clove-brown ; on anterior surface of hind tibiae of ♀ cream-coloured area extends further than on upper surface, occupying about proximal two-thirds, while on upper surface paler area scarcely reaches middle ; pale portion of hind tibiae of ♀ clothed with silvery-white hair, remainder clothed with black hair ; tarsi in both sexes clove-brown, last joint of front pair deeply notched at tip, second and two following joints of front pair conspicuously expanded.

Uganda and East Africa Protectorates : type of ♂ and twelve ♂ para-types from Bugoma Forest, Unyoro, Uganda Protectorate, 3,700 feet, 1–5.xii.1911 (*S. A. Neave*); two other ♂♂ from Entebbe, Uganda,—"in forest," 5.vii.1911, and between 12 and 20.i.1912 (*S. A. Neave*); type of ♀ and seven ♀ para-types from Uganda, 1910 (*Captain A. D. Fraser, R.A.M.C.*); six ♀♀ from Bugoma Forest, Uganda Protectorate, as above (*S. A. Neave*); three ♀♀ from Mabira Forest, Chagwe, Uganda Protectorate, 3–500–3,800 feet, 16–25.vii.1911 (*S. A. Neave*); one ♀ from the Botanical Gardens, Entebbe, Uganda, 5.ix.1904 (*Captain*, now *Major, E. D. W. Greig, I.M.S.*) ; one ♀ from Uganda, 1909 (*Colonel*, now *Surgeon-General, Sir David Bruce, C.B., F.R.S.*); one ♀ from Mpumu, Chagwe, Uganda Protectorate, March, 1910 (*Captain*, now *Major, A. E. Hamerton, D.S.O., R.A.M.C.*) ; one ♀ from the Luimi River, Toro, Uganda Protectorate, 22.i.1911, "in forest country ; a common and very pretty *Tabanus*" (*Dr. R. Van Someren*); one ♀ from the Yala River (southern edge of Kakumega Forest), East Africa Protectorate, 4,800–5,300 feet, between 21 and 28.v.1911 (*S. A. Neave*). The ♂ type, eight other ♂♂, and six ♀♀ taken by Mr. Neave (in whose honour this handsome species has been named) have been presented to the British Museum (Natural History) by the Entomological Research Committee, in whose possession are the remaining specimens collected by Mr. Neave ; the specimens enumerated above other than those obtained by Mr. Neave have been presented to the National Collection by their captors.

The differences between *Tabanus neavei*, Austen, and *T. insignis*, Lw., have been dealt with in the diagnosis at the commencement of the foregoing description. The new species is also closely allied to *Tabanus velutinus*, Surcouf, which is found in Abyssinia and the East Africa Protectorate, and is most readily distinguishable from *T. neavei* by the absence of the conspicuous oblique grey stripes on the second abdominal segment, as seen in the latter, by the much paler (burnt umber) colour of the proximal portion of the dorsum of the abdomen, and by the entire ventral surface of the latter, except at the distal extremity, being pale (ochraceous-buff or pale cinnamon), and clothed with glistening, pale yellowish hair. Among other differences between *Tabanus neavei* and *T. velutinus* may be mentioned the more slender and elongate shape of the third joint of the antennae in the former (at any rate in the female sex), and the darker coloration of the hind tibiae and of the terminal joint of the palpi.

### Genus Haematopota, Meigen.

Owing to pressure upon the author's time, it has proved impossible to prepare a *detailed* description of the first of the two following species; it is hoped however that the essential characters have been duly noted, and that the condensed description below, in conjunction with the figure of the ♂ (Plate XI, fig. 7), will enable the species to be recognised.

**Haematopota furva,** sp. n. (Plate XI, fig. 7).

♂ ♀.—Length, ♂ (5 specimens) 8·4 to 9·4 mm., ♀ (27 specimens) 8·4 to 11·2 mm.; width of head, ♂ 3 mm., ♀ 2·8 to 3·8 mm.; width of front of ♀ at vertex 0·75 to 1·25 mm.; length of wing, ♂ 7 to 8·4 mm., ♀ 8·2 to 10·5 mm.

*Medium-sized, blackish species*, with dorsum of *thorax* unicolorous in ♂, and in ♀ inconspicuously marked with the commencements of three grey longitudinal stripes on anterior border and two grey dots near centre; both sexes with *tergites of first six abdominal segments each bearing a pair of rounded or elongate, mouse-grey spots*, forming two converging longitudinal series; hind margins of abdominal segments also mouse-grey; *eyes* in ♂ densely clothed with short hair, inconspicuously hairy in ♀; larger facets in eyes of ♂ only to a moderate extent exceeding the smaller facets in size; *frontal callus* in ♀ black, of moderate depth, its upper margin straight or nearly so, or slightly curved; *palpi* blackish slate-coloured in ♂, mouse-grey in ♀, in which sex terminal joint is moderately or only slightly thickened towards base; first joint of *antennae* shining black, second and third joints dull clove-brown, all joints dark greyish pollinose, first joint conspicuously swollen in ♂, only slightly so in ♀, third joint elongate, expanded portion in ♀ moderately broad at base when viewed from the side; *wings* dark sepia-coloured, with clearly defined light markings (forming the usual three rosettes), majority of which are generally much broken up into dots, so as to appear more or less moniliform, and in ♀ sex especially look as if traced by point of a needle; *stigma* dark brown, well-defined; pale loop in marginal cell immediately beyond stigma usually conspicuous, complete or incomplete, sometimes contracted into a pale spot in which the darker centre is scarcely distinguishable; base of third longitudinal vein, anterior transverse vein, posterior half of distal boundary of second basal cell, distal boundary of discal

cell, and base of anterior branch of third longitudinal vein as also its appendix conspicuously though narrowly infuscated; *legs* clove-brown or black, anterior tibiae with a single pale band near base (in ♂ often scarcely distinguishable, darker than in ♀, and incomplete above), middle and hind tibiae each with two pale bands (ochraceous-buff in ♂, buff or cream-buff in ♀); anterior tibiae of ♀ slightly but distinctly swollen, hind tibiae not swollen; proximal two-thirds of first joint of middle and hind tarsi cream-buff.

Uganda and East Africa Protectorates: type of ♂ and two ♂ paratypes from Daro or Durro Forest, Toro, Uganda Protectorate, 4,000-4,500 feet, 25-29. x. 1911; one ♂ from the Yala River (southern edge of Kakumega Forest), East Africa Protectorate, 4,800–5,300 feet, 21-28. v. 1911; two ♂♂ from Tiriki, North Kavirondo, East Africa Protectorate, 5,200 feet, 20. v. 1911; type of ♀ from Ilala (14 miles east of Mumia's), Maramas District, East Africa Protectorate, 4,500 feet, between 18 and 21. vi. 1911; additional ♀♀ from the East Africa Protectorate as follows:—four from the south-eastern slopes of Mt. Kenya, 6,000–7,000 feet, 3-12. ii. 1911; two from Tiriki (other details as above); two from the Yala River (other details as above); two from the Nandi Escarpment, 5,800 feet, 29. v. 1911; and one from the southern foot and slopes of Mt. Elgon, 5,100-5,800 feet, between 8 and 13. vi. 1911. From the Uganda Protectorate ♀♀ as follows:—three from Mabira Forest, Chagwe, 3,500-3,800 feet, 16–25. vii. 1911; one from Western Ankole, 4,500–5,000 feet, between 10 and 14. x. 1911; one from south of Lake George, 3,200–3,400 feet, between 17 and 19. x. 1911; one from the Ankole-Toro border, east of Lake George, 4,500 feet, 20-21. x. 1911; five from Daro or Durro Forest (other details as above); one, locality and date of capture unknown (*Dr. C. A. Wiggins*). Of the foregoing examples, all of which except the last were collected by *Mr. S. A. Neave*, the ♂ and ♀ types, three other ♂♂ and fifteen ♀♀ have been presented to the British Museum (Natural History) by the Entomological Research Committee, by whom the remainder are for the present retained. In addition to those already mentioned, the National Collection also includes the following ♀ specimens of this species from the Uganda Protectorate:—one from Mabira Forest, Chagwe, 12. iv. 1905 (*Dr. C. Christy:* presented by the Liverpool School of Tropical Medicine); one from the vicinity of (15 miles from) the Missisi River, 1909 (received from Colonel, now Major-General, Sir David Bruce, C.B., F.R.S.); two (precise locality and date of capture unknown), 1910 (*Captain A. D. Fraser, R.A.M.C.*).

In the female sex, at any rate, *Haematopota furva* may be distinguished from *H. fusca*, Austen,—another dark and dark-winged species with apparently much the same distribution in the Uganda and East Africa Protectorates—by its broader and bulkier body, more conspicuously spotted abdomen, much darker (black or blackish) antennae and frontal callus, and by the infuscation of certain of the wing-veins or portions of veins, as described above. From *Haematopota hirta*, Ric. (syn. *H. nigrescens*, Ric.), which also occurs in the Uganda and East Africa Protectorates and resembles *H. furva* in size and in the shape of its thorax and abdomen, the species just described is in the female sex readily distinguishable *inter alia* by its much narrower front, much larger and darker antennae, which in *H. hirta* are small and cinnamon-coloured, and by its darker body and wings.

**Haematopota neavei,** sp. n. (Plate X, fig. 9.)

♂ ♀.—Length, ♂ (1 specimen) 11·6 mm., ♀ (18 specimens) 10 to 12 mm.; width of head, ♂ 4 mm., ♀ 3·4 to 4 mm.; width of front of ♀ at vertex 1 mm.; length of wing, ♂ 9·25 mm., ♀ 8·75 to 11 mm.

*Large species, clove-brown in ♂, partly dark-brown, partly mummy-brown (ground-colour of tergites of first three abdominal segments mainly mummy- or reddish-brown) in ♀, with narrow front in latter, and in both sexes with paler longitudinal stripes on dorsum of thorax, and dark brown or sepia-coloured wings, in which the usual pale markings, at least in anterior and proximal two-thirds, are distinctly tinged with ochraceous-buff.*

*Head* yellowish-grey pollinose (more distinctly yellowish in ♀ than in ♂); *front* in ♀ darker, dull ochre-yellow pollinose, with a dusky (dark sepia-coloured) median patch on vertex, and clove-brown lateral frontal spots very conspicuous, rounded, and in contact with eyes; *frontal callus* in ♀ clove-brown, fairly deep from above downwards, transversely oblong, its upper angles rounded off; *eyes* bare in both sexes, larger facets in ♂ not coarse; *palpi* dark mouse-grey in ♂, isabella-coloured in ♀, terminal joint in latter moderately swollen towards base; first joint of *antennae* in ♂ moderately swollen, elliptical ovate in outline when viewed from above, shining black, covered, at least in part, with dark grey pollen, and clothed with black hair; second and third joints of antennae in ♂ dark mummy-brown, expanded portion of third joint narrow and elongate as viewed from side, terminal annuli of third joint dark brown, short, and ending bluntly; first joint of antennae in ♀ dark mummy-brown or reddish-brown, darker at distal extremity, moderately swollen, elliptical oval when viewed from above, broader at distal extremity than at base when viewed from side; expanded portion of third joint of antennae in ♀ burnt-umber-coloured, large and elongate (cuneate in outline when viewed from side), terminal annuli clove-brown, short. *Thorax:* main portion of dorsum in ♂ with lateral and posterior borders, a complete median longitudinal stripe (very narrow in front, broader posteriorly), and two broader admedian longitudinal stripes (more or less interrupted beyond transverse suture) yellowish-grey pollinose; dorsum in ♂ clothed for most part with erect, blackish hair, but on and towards posterior border paler markings clothed with yellowish hair; dorsum of scutellum in ♂ with an indistinct dull yellowish-grey pollinose median patch at base, produced posteriorly into a narrow median stripe; pleurae and pectus in ♂ dusky grey pollinose, and clothed with blackish hair; main portion of dorsum in ♀, with lateral and posterior borders, and three longitudinal stripes (including a narrow median stripe and two broader admedian ones—the latter suddenly diminishing in width a little beyond transverse suture, then broadening again, and converging posteriorly until they become fused with median stripe on hind border) yellowish isabella-coloured pollinose; dorsum of scutellum in ♀, except a dark brown patch on each lateral border (narrowly separated from its fellow at the tip), yellowish isabella-coloured pollinose; dorsum of thorax in ♀ clothed with short, glistening, ochre-yellow hairs, intermingled with or replaced by black hairs on dark markings; immediately in front of base of each wing is a dusky (mouse-grey or clove-brown) longitudinal streak, clothed with black hair; pleurae and pectus in ♀ smoke-grey or yellowish-grey pollinose, clothed with yellowish hair (pectus with

a transverse ridge of black hair in front of bases of middle coxae). *Abdomen:* hind borders of all tergites in ♂, and of all except first in ♀, isabella-coloured pollinose, more dusky in ♂ than in ♀; hind border of second tergite in ♂ produced in middle line into a narrow, forwardly directed triangle, which scarcely extends beyond middle of segment; a similar expansion sometimes visible, though less distinctly, on second tergite of ♀ also; a pair of rounded, yellowish-isabella-coloured spots more or less indistinctly visible on each tergite (or on each except first) in ♀; in ♂, so far as can be judged from the single specimen available, corresponding spots are less developed, and are confined to a mere vestige (only visible when abdomen is viewed from behind at a low angle) on sixth tergite; venter in ♂ slate-grey in front, greyish clove-brown posteriorly, hind margins of second and following scutes isabella-coloured; dorsal and ventral surfaces of abdomen in ♂ clothed with black hair, with which on ventral scutes of third to sixth segments inclusive some yellowish hairs are intermingled; ventral surface in ♀ greyish-drab (terminal scute with a dark brown patch in centre), clothed, except on last segment, with glistening, appressed, ochre-yellow hairs, with which on penultimate segment some more erect brownish hairs are intermingled; dorsum in ♀ clothed with minute, appressed, black or blackish hairs (lateral margins of first six dorsal scutes often clothed, at least in part, with glistening ochre-yellow or yellowish hairs). *Wings:* usual three rosettes, pale mark in marginal cell at distal extremity of stigma, and sinuous mark or transverse streak just before apex of wing (starting from costa at distal extremity of first submarginal cell) generally well developed; *stigma* dark brown, well developed and conspicuous, its proximal extremity pale; discal cell with two pale transverse marks (portions of proximal and median rosettes), and with its proximal angle also pale; distal marginal angles of second, third, and fifth posterior cells pale; zig-zag pale mark running across proximal extremity of distal third of anal and axillary cells usually well developed and conspicuous; veins or portions of veins surrounded by the three rosettes more or less distinctly infuscated. *Squamae* sepia-coloured. *Halteres* cream-buff. *Legs:* middle and hind coxae and anterior surface of base of front coxae in ♂ grey, remainder of front coxae in ♂ clove brown; coxae in ♂ clothed with black or blackish hair, except on anterior surface of base of front pair, where hair is greyish or yellowish; coxae in ♀ grey and clothed with yellowish hair, except distal two-thirds of front pair, which are dark brown and clothed with similarly-coloured or blackish hair; femora in ♂ and also middle and hind tibiae and tarsi clove-brown, front tibiae and tarsi in ♂ black, front tibiae in ♂ with a cream-buff band, clothed with appressed, glistening, cream-coloured hairs, close to base, middle and hind tibiae in ♂ each with two cream-buff or buff-coloured bands, the distal band being narrower than that near the base, and in the case of the hind tibiae (at least in the typical specimen) indistinct and inconspicuous; middle and hind tarsi of ♂ clove-brown, proximal two-thirds of first joint of middle pair, and rather more than proximal half of first joint of hind pair cream-buff; hind tibiae in ♂ fringed with black hair on inner and outer sides, the hair composing the fringe on the outer side being coarser and more uniform in length than that on the inside; femora in ♀ clove-brown, and clothed for most part with similarly coloured hair, proximal two-thirds of middle pair (at least on posterior surface)

often paler and clothed with glistening yellowish hair ; coloration and markings of tibiae and tarsi in ♀ as in ♂, the distal pale band on the hind tibiae varying in distinctness in different individuals, the fringes on the hind tibiae distinct but shorter than in ♂ ; front tibiae not incrassate in ♂, moderately incrassate in ♀, hind tibiae in ♀ broader than middle tibiae but not incrassate.

UGANDA PROTECTORATE: Tero Forest, south-east Buddu, 3,800 feet, 26–30.ix.1911 (*S. A. Neave*); the typical specimens of both sexes and eight of the seventeen ♀ para-types are in the British Museum, having been presented by the Entomological Research Committee, in whose possession are the remaining para-types of this handsome addition to the TABANIDAE of Tropical Africa.

*Haematopota neavei*, which has been named in honour of its discoverer, is allied to *H. inornata*, Austen, which also occurs in Buddu, Uganda, where the co-types were obtained in November 1902, by Dr. C. Christy. *H. inornata*, which resembles *H. neavei* in size, may however, in the female sex, at any rate, be distinguished from the new species *inter alia* by the third joint of its antennae as viewed from the side being much narrower, by its thorax being much less conspicuously striped, by its wings having a noticeably longer stigma, and by its front tibiae being less swollen.

## COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st April and 30th June, 1912) :—

Dr. W. M. Aders :—7 Hymenoptera, 2 Coleoptera, 1 Orthopteron, 14 Coccidae, 36 Termites, 3 Lepipdopterous larvae, 234 Fleas, 11 Anoplura and a number of Mites ; from Zanzibar.

Mr. T. J. Anderson :—195 Culicidae, 21 Mycetophilidae, 25 other Diptera, 22 Chalcididae, 361 Coleoptera, 34 Lepidoptera, a number of Coccidae, 11 other Rhynchota and 1 Arachnid ; from Nairobi, British East Africa.

Mr. H. A. Ballou :—28 Melolonthidae, Rutelidae and Dynastidae ; from British West Indies.

Dr. H. A. Bödeker :—5 Culicidae, 2 *Glossina*, 6 *Stomoxys*, 4 other Diptera, 4 Hymenoptera, 37 Coleoptera, 113 Lepidoptera, 3 Odonata, 3 Rhynchota, 1 Orthopteron, 2 Arachnida ; from Nakuru, British East Africa.

Mr. John R. Bovell :—2 *Tiphia parallela* ; from Barbados.

Mr. E. Brand :—4 Culicidae, 3 *Tabanus*, 1 *Haematopota*, 1 *Glossina*, 1 Hippoboscid, 2 *Auchmeromyia*, 3 other Diptera, 1 Flea, 10 Ticks, 2 Trombidiidae and 7 Worms ; from Malindi, British East Africa.

Mrs. Henry Brown :—1 *Auchmeromyia*, 75 other Diptera and 4 Hymenoptera ; from Mlanje, Nyasaland.

Dr. B. W. Cherrett :—1 *Anopheles*, 152 Tabanidae, 1 *Glossina*, 11 other Diptera ; from British East Africa.

Dr. J. B. Davey :—17 Culicidae, 25 *Tabanus*, 11 *Haematopota*, 12 *Glossina*, 7 Hippoboscidae, 2 *Auchmeromyia*, 1 *Nycteribia*, 1 Dipterous larva, 3 Hymenoptera, 3 Coleoptera, 2 Cicadas, with nymph cases, 8 other Rhynchota, 2 Orthoptera, 28 Ticks, and 20 Worms ; from Nyasaland.

Mr. C. M. Dobbs :—15 Culicidae, 2 *Tabanus*, 1 *Haematopota*, 1 *Chrysops*, 9 other Diptera, 29 Hymenoptera, 22 Coleoptera, 3 Lepidoptera, 1 Ephemerid, 1 Dragon-fly, 16 Rhynchota, 8 Orthoptera, 5 Fleas, 1 Louse, 4 Ticks, 1 Millipede, and 1 Wasps' nest ; from Kericho, British East Africa.

Dr. R. E. Drake Brockman :—79 Culicidae and 8 *Lyperosia* ; from British Somaliland.

Dr. H. Lyndhurst Duke :—3 *Culicoides*, 7 *Simulium*, 80 *Tabanus*, 43 *Haematopota*, 8 *Chrysops*, 8 *Rhinomyza*, 4 *Glossina*, 9 *Stomoxys*, 22 other Diptera, and about 20 Oestrid larvae from nose of haartebeeste ; from Uganda.

Capt. T. W. P. Dyer and W. Hastings :—136 *Glossina* ; from Northern Nigeria.

Mr. A. E. Evans :—21 *Balanogastris kolae* (and 41 larvae and pupae), 15 *Epuraea*, 30 *Sahlbergella theobroma* and 7 Psocidae ; from Aburi, Gold Coast.

Mr. J. H. J. Farquhar :—2 Culicidae, 7 *Tabanus*, 4 *Chrysops*, 11 *Glossina* and 3 other Diptera ; from Southern Nigeria.

Mr. T. E. Fell :—2 Culicidae, 12 *Tabanus*, 6 *Haematopota*, 39 *Glossina*, 2 other Diptera, and 1 *Nemopistha*; from Western Ashanti.

Capt. J. Fraser :—2 *Haematopota*, 31 other Diptera, 80 Hymenoptera, and 13 Coleoptera; from Uganda.

Dr. Fyffe :—15 Diptera, 6 Hymenoptera, 6 Coleoptera, 14 Rhynchota, 2 Orthoptera and 69 Ticks; from Uganda.

Dr. Mercier Gamble :—8 Culicidae, 4 *Tabanus*, 8 other Diptera; from San Salvador, Portuguese Congo.

Mr. C. C. Gowdey :—2 Diptera, 282 Hymenoptera, 248 Coleoptera, a number of Coccidae, 167 other Rhynchota, 68 Orthoptera, 1 Centipede and 2 Ticks; from Entebbe, Uganda.

Mr. J. A. Ley Greaves :—86 *Glossina*; from Northern Nigeria.

Mr. F. G. Hamilton :—6 Culicidae, 106 Tabanidae, 49 other Diptera, 244 Hymenoptera, 249 Coleoptera, 4 Lepidoptera and 60 Rhynchota; from Magadi, British East Africa.

Dr. J. A. Haran, C.M.G. :—3 Culicidae, 11 *Tabanus*, 2 other Diptera, 146 Cimicidae and 12 Ticks; from Nairobi, British East Africa.

Dr. A. D. P. Hodges :—2 Culicidae and 2 *Glossina*; from Entebbe, Uganda.

Dr. E. Hopkinson :—38 *Tabanus*, 101 *Glossina*, 5 other Diptera, 10 Hymenoptera; from Gambia.

Mr. Ll. Lloyd :—18 *Tabanus*, 3 *Haematopota*, 1 *Chrysops*, 1 *Glossina*, 1 *Stomoxys* and 1 Asilid; from Northern Rhodesia.

Dr. John McConaghy :—16 Culicidae, 3 *Glossina*; from Sierra Leone.

Dr. R. E. McConnell :—32 Culicidae, 5 *Tabanus*, 80 *Haematopota*, 42 *Glossina*, 1 *Auchmeromyia*, 1 Asilid, 16 *Culicoides*, 46 other Diptera, 5 Hymenoptera, 2 Coleoptera, 3 Odonata, 4 Rhynchota, 2 Fleas and 1 Tick; from Uganda.

Dr. B. Moiser :—42 *Glossina tachinoides*, and 3 other Muscidae; from Geidam, Northern Nigeria.

Mr. R. E. Montgomery :—492 Ticks; from Nairobi, British East Africa.

Capt. C. A. Neave :—22 *Glossina*, 5 Hippoboscidae, 120 other Diptera, 6 Dipterous larvae, 93 Hymenoptera, 32 Coleoptera, 25 Rhynchota, 40 Ticks and 8 Trombidiidae; from British East Africa.

Mr. S. A. Neave :—104 Culicidae, 288 Tabanidae, 42 *Glossina*, 4 Hippoboscidae, 126 other Diptera, 555 Hymenoptera, 1,585 Coleoptera, 2,939 Lepidoptera, 1 Ascalaphid, 3 Odonata, 595 Rhynchota, 10 Orthoptera, 10 Cimicidae and 4 Ticks; from British East Africa.

Dr. Lucius Nicholls :—16 *Anopheles* and 21 larvae; from St. Lucia.

Dr. H. B. Owen :—1 *Stegomyia*, 8 *Tabanus*, 66 *Haematopota*, 1 *Chrysops*, 7 *Glossina*, 6 Hippoboscidae, 33 other Diptera, 2 Mallophaga, 1 Arachnid; from Uganda.

Mr. H. B. Partington :—33 Hippoboscidae; from Turkana District, British East Africa.

Mr. A. B. Percival :—1 Culicid, 1 *Tabanus*, 13 *Haematopota*, 3 *Glossina*, 16 Hippoboscidae, 7 Coleoptera and 2 Lepidoptera; from British East Africa.

Dr. Owen Prichard :—12 Culicidae, 2 *Haematopota*, 6 other Diptera, 3 Hymenoptera, 3 Coleoptera, 2 Lepidoptera, 11 Odonata, 2 Rhynchota, 3 Ticks, 1 Chelifer and 4 other Arachnida ; from British East Africa.

Dr. W. J. Radford :—14 Culicidae, 1 *Glossina austeni*, 4 *Stomoxys*, 43 other Diptera, 11 Hymenoptera and 3 Orthoptera ; from Mombasa.

Capt. A. C. Saunders :—70 Culicidae, 87 Tabanidae, 16 *Lyperosia*, 1 Hymenopteron, 60 Ticks and 1 Scorpion ; from Lake Rudolf, British East Africa.

Mr. S. W. J. Scholefield :—73 Diptera, 43 Hymenoptera, 10 Coleoptera, 2 Lepidoptera, 2 Planipennia, 11 Rhynchota, 10 Orthoptera, 1 Bees Nest and 3 Arachnida ; from Kitui, British East Africa.

Dr. Jas. J. Simpson :—16 Culicidae, 99 *Tabanus*, 28 *Haematopota*, 157 *Glossina*, 95 other Diptera, 64 Hymenoptera, 276 Coleoptera, 632 Lepidoptera, 1 Planipennia, 106 Odonata, 37 Rhynchota, 4 Orthoptera, 1 Flea and 261 Ticks ; from Sierra Leone.

Dr. A. H. Spurrier :—9 *Ceratopogon* ; from Zanzibar.

H.E. The Governor, Straits Settlements :—34 *Sessinia* sp. ; from Cocos Keeling Islands.

Dr. G. C. Strathairn :—7 Culicidae ; from Uganda.

Mr. R. P. Thomas :—5 *Glossina*, 1 Coleopteron, 12 Cimicidae and 34 Ticks ; from Mombasa.

Mr. E. C. Chubb, 16 *Glossina pallidipes* ; from Zululand.

Dr. G. R. Twomey :—12 Culicidae, 7 *Tabanus*, 1 *Chrysops*, 150 *Glossina* and 16 other Diptera ; from Northern Nigeria.

Mr. F. W. Urich :—5 Dynastidae, 5 Passalidae, 20 Curculionidae, 74 Scolytidae, 19 Eumolpidae, 19 Coleopterous larvae and pupae, 5 Dipterous larvae ; from Trinidad.

Dr. R. Van Someren :—1 Culicid, 8 Hymenoptera, 3 Coleoptera, 2 Orthoptera, 2 Anoplura ; from Uganda.

Dr. W. M. Wade :—20 Culicidae, 24 Tabanidae, 62 *Glossina*, 1 Hippoboscid, 10 other Diptera, 9 Hymenoptera, 12 Coleoptera, 2 Lepidopterous larvae, 2 Rhynchota and 2 Arachnida ; from Western Ashanti.

Dr. C. A. Wiggins :—7 Tabanidae, 1 *Glossina*, 4 Asilidae, 57 Hymenoptera, 100 Coleoptera, 4 Lepidoptera, 41 Rhynchota, 3 Orthoptera ; from Entebbe, Uganda.

Dr. K. S. Wise :—33 Siphonaptera, 3 Anoplura, and 6 *Cimex* ; from British Guiana.

Dr. J. Y. Wood :—7 Tabanidae, 69 *Glossina* ; from Sierra Leone.

Mr. C. M. Woodhouse :—43 Culicidae, 38 *Tabanus*, 39 *Haematopota*, 27 *Glossina*, 3 Hippoboscidae, 124 *Stomoxys*, 4 *Auchmeromyia*, 19 other Diptera, 2 Rhynchota and 1 Arachnid ; from British East Africa.

Mr. R. B. Woosnam :—1 Culicid, 20 Hymenoptera, 28 *Glossina*, 14 Hippoboscidae, 3 *Stomoxys*, 3 other Diptera and 29 Ticks ; from British East Africa.

# THE BEARING OF PHYSIOLOGY ON ECONOMIC ENTOMOLOGY.*

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The progress of applied Entomology is mainly visible in the discovery of practical means for the destruction of insects injurious to cultivated plants, and in the minute determination of the various stages of the growth and development of such insects. More recently the parasites of insect pests, both of vegetable and animal origin, have also largely attracted attention. But physiological research, so far as injurious insects are concerned, has almost entirely been overlooked and neglected ; although this line of enquiry affords obvious opportunities for arriving at the very essence of the whole matter, and should indeed be made one of the main starting points in the study of insect pests.

In such circumstances it may be interesting to show how the study of physiology bears in a remarkable way on several questions of entomological research to which I have devoted special attention.

## The Tropisms.

Whereas the study of tropisms in Botany is nothing new, it is only of recent date as regards animals. So far as I have been able to ascertain, the earliest published communications on tropisms in animals were those of authors who occupied themselves with the chemotropism of leucocytes, and these were followed by the investigations of Hermann[23] and myself.[1] While I found and described for the first time the reaction of animals to contact (later authors called it stereotropism), Hermann discovered electrotropism in his experiments on tadpoles.

The form of tropism which interests us most here is phototropism, from which has originated the long established method of catching and destroying injurious insects by means of artificial light. The modest beginning of the method may be traced back as far as 1787, when the Abbé Roberjot, parish priest of St. Vérand, near Mâcon, systematically caught the vine moths, *Sparganothis pilleriana*,† by means of lighted candles placed on the window-sills of his house and of wood fires in the vineyards. Since then insect trap-lanterns have been gradually developed and improved with the progress of science and industry, until we find to-day the most perfected modern acetylene lamps almost everywhere, and in the vineyards of the Champagne (France) even most complicated electrical installations, specially designed for catching and destroying injurious insects. But although the trap-lantern, so far as its exterior aspect and construction are concerned, has been brought to high perfection, the method itself has so far been treated almost in a wholly empirical manner. Much labour and thought have been devoted to the perfecting of the trap-lantern method, and much has been

* This article has been kindly translated for me by Mr. F. Clotten, of London.

† [Mr. J. H. Durrant informs me that the generic name *Oenophthira*, used by the author, is no longer recognised by Microlepidopterists—Ed.]

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written about it; but hardly anyone has considered and been guided in his efforts by wider scientific aspects.

Surely it must strike one as strange indeed that the most varied sources of light have been utilised without examining, on the one hand, the various lights spectroscopically, as to their composition, and without studying, on the other hand, the power of attraction of the various rays of light upon different insects. T. Perraud[31] is apparently the only investigator who so far has entered into these questions. He projected a large spectrum on a screen in a dark room and observed the aggregation of the moths, *Clysia* (*Conchylis*) *ambiguella* and *Sparganothis pilleriana*, on the different colours of the spectrum. He found that the less refractive colours of the spectrum, namely red to green, exercised by far the strongest attraction. Some time ago also experiments were made in vineyards at Saarburg (Saar, Germany),[17] with lamps provided with glass covers of various colours. It was found that the lamps with green glass had attracted the largest number of insects. These results also agree with the observations which Hess[24] made with fishes, which clearly demonstrated that fish flock in largest numbers to yellow-green colours of a spectrum thrown on the water.

Again, it would be certainly a great advantage if the strength of the various lights were exactly measured photometrically, in order to ascertain the optimum degree of illumination for trapping insects.

In connection herewith the study of the degrees of attraction which various artificial lights exercise upon the sexes should prove of great interest and might be useful for practical purposes. A number of experiments have already been made in order to ascertain the sexual proportion of the insects caught, but so far the figures resulting therefrom do not admit of formulating a fixed rule or drawing definite conclusions. When at the Station de Pathologie Végétale at Villefranche (Rhône) of Mr. Vermorel, I[9] carried out over a long period a series of such experiments with acetylene lamps and obtained fairly definite results regarding some insects. I ascertained that the percentage of the captured females gradually increased from the BOMBYCIDAE upwards to the Microlepidoptera; further, that in my various experiments each of the groups appeared to possess a tendency to furnish a fixed number of female victims. With BOMBYCIDAE the percentage of the females was 4, with NOCTUIDAE 19, with GEOMETRIDAE 27, and with TINEINA 39. Simultaneously I observed that the percentage of females of *Sparganothis pilleriana* (TINEINA), a pest of the vine, which had been caught with acetylene lamps by Messrs. Vermorel and Gastine, was 40, which is almost identical with the percentage of 39 ascertained by me for Microlepidoptera in general. Laborde[25] found the same percentage for the females of *Clysia* (*Conchylis*) *ambiguella* (TINEINA).

Moreover, in connection with insect trap-lanterns, it is probable that certain changes in the physiological conditions of the individual insects or of the sexes may take place which in turn may influence the number of individuals that may be on the wing at any given time. What, for instance, may in this respect be the effect of cold or of heat? Or is the flight of the females diversely influenced by the complete possession, or the partial or complete evacuation of the eggs? Such questions have already been put, but their practical study and solution have so far never been seriously attempted. From observations made by

Gastine[21] and myself it is, however, permissible to conclude that the colder the night the fewer the females (and, in particular, females with eggs) that are caught by acetylene trap-lamps. Strange occurrences may be observed in this respect. Of *Porthesia chrysorrhoea* not many specimens were generally caught and rarely indeed females; but then followed nights when very many specimens were caught, and amongst them also some females. Altogether I caught during such experiments 940 specimens of *Porthesia* of which only 24 were females. Strange to say, nine catches, yielding altogether 562 specimens (averaging 62·4 specimens per catch) furnished me with 24 females, whereas 94 catches yielding in all 378 specimens (averaging only four specimens per catch) did not supply one single female. Hence one may conclude from such results that there exist in the atmosphere peculiar conditions, so far unknown to science, which affect the flying tendency of insects during night time according to their sex.

I will mention here a case of phototropism which has been investigated by E. Molz.[29] The experiments were carried out for the purpose of ascertaining the reason of the well known fact that some insect larvae invariably rest on the upper side of leaves, while others seek the lower side. The larva investigated was that of *Eriocampa adumbrata*, which lives on leaves of the cherry tree. It was found that these larvae always endeavour to orient themselves so that the rays of light fall vertically upon their backs; hence, under natural conditions, they are only found on the upper surface of the leaf.

I can only hint here at some of the effects of phototropism on insects and their larvae; how it dominates their choice of location; how it forces them now to live in full light and at other times under quite opposite surroundings, in order to perform their metamorphoses; how it causes some to go in search of food during the day, others during the night. All these varying conditions are of the utmost importance for the study of the life and destruction of injurious insects and should in their various bearings be brought under one common physiological aspect. We may, therefore, do well to bear in mind here that recently Oswald[30] has connected phototropism of animals with certain enzymes which are found in them. According to him phototropic reactions are intimately connected with the respiratory action of the tissues. Positively phototropic animals are rich in catalase and poor in peroxydase, whereas with negatively phototropic animals the reverse conditions prevail.

Reaction to contact or stereotropism is widely distributed amongst the lower animals, and the mode of living and conduct of many species can be traced back to it. With animal spermatozoa, which possess this attribute in a high degree, it is perceptible, as Massart[28] and I[4] have demonstrated, in their desire either to attach themselves closely to solid substances or to penetrate into porous ones; and similar reactions may be observed in the behaviour of snails, earth-worms, nematode worms and other lower animals, which dispose themselves in response to this stimulus. Insects and their larvae endeavour to fasten their bodies tightly to corners or to sharp and prominent objects, or to squeeze themselves between layers of folded dry goods. On these facts is based the employment of belts round fruit trees in order to catch the larvae of *Laspeyresia* (*Carpocapsa*) *pomonella*; also the use of paper bands or cloth strips for catching the caterpillars of the TORTRICIDAE of the vine; likewise the use of flat stones or wooden boards in

gardens for collecting below them various invertebrates such as earwigs, slugs, etc., and then destroying them wholesale. Both P. Marchal[27] and I[11] have arrived at the conclusion that the female of the grape-moth, *Clysia ambiguella*, when laying its eggs on the flower-buds and berries of the vine, is guided by the highly sensitive extremity of its abdomen. And this sensitiveness of the point of the abdomen also causes the females of many insects to lay their eggs in fissures and folds of plants, of the soil, and other substances. One can easily watch such females feeling their way searchingly with the finger-shaped outstretched abdomen. According to Seitz[33] full-grown caterpillars of *Gastropacha neustria*, which at that time live solitary, adhere lengthways to one another in two and threes, thus incontestibly demonstrating their reaction to the stimulus of contact. This observation may lead us to the causes of the gregarious habits of many insects. It is well known that many caterpillars, when young, live huddled together in common nests, thereby facilitating their destruction. But later on, under the influence of physiological changes in their internal conditions, these insects separate and lead a solitary, individualistic life. Under certain influences their former gregarious and socialistic mode of existence can, however, be restored. Such conditions are also found amongst higher animals. Birds assemble and form enormous swarms at certain seasons, fishes congregate and in their millions ascend rivers or descend into the sea when their products of reproduction are ripening. Hence age, season, or reproduction may evidently influence individual animals to become gregarious. According to J. Loeb the olfactory sense also performs an important function in this connection.

Geotropism, or the tendency of living organisms to be attracted towards the centre of the earth, may frequently combine with phototropism and thereby force animals to locate themselves on the extreme ends of tree branches and on the crowns of trees (negative geotropism), or to descend into the soil (positive geotropism).

Rheotropism, into which I[5] have made researches in connection with various classes of lower animals and which is particularly pronounced in those that live in water, shows itself in the tendency and efforts of animals to head against the current of water or air and to remain or move in that position. This fact can readily be observed with fishes in small streams. Or one may fill a large round glass jar with water, then place in it some water animals—say newts—and then move the water round. The newts in the water or the *Hydrometra*, which race about on the surface, will head at once against the current. So far as the air currents themselves are concerned, the study of rheotropism has received scant attention. Wheeler[36] calls this anemotropism and defines it as signifying the tendency and efforts of those insects which float and glide about in the air to face the wind current. To such insects belong *Bibio*, *Anthomyia*, *Syrphus*, *Bombylius*, SPHINGIDAE, and ODONATA. Amongst flies sometimes only males are anemotropic; Osten-Sacken found that with the Diptera the faculty of floating in the air is closely connected with the holoptic heads of the males. The Rocky Mountain locusts (*Melanoplus spretus*) fly with the wind in a light breeze, but as soon as the velocity of the wind rises they fly against it.

It is not at all unlikely that rheotropism causes many species to build their nests and habitations facing the prevailing winds. Schmarda[3] mentions that in

Australia the termites build their earth heaps in long rows from north-west to south-east, which corresponds with the direction of the prevailing wind.

The sense of smell and the power of attraction exercised by smelling substances play a most important part in insect life. J. Pérez and F. Plateau have made exhaustive researches into the power of attraction exercised by flowers and their scents upon insects. And it must not be lost sight of here that the two sexes find each other by the sense of smell. That fact has long ago been turned to practical use for catching and destroying insects; and in particular, collectors have utilised scented liquids for such purposes. Since 1910 this method has been applied for the first time against the moths of the grape-worms (*Clysia ambiguella* and *Polychrosis botrana*)—see J. Dewitz.[17] Efforts have been and are being made to discover by empirical methods those substances which exercise the most powerful attraction upon the organs of smell of these moths, and in connection therewith one fact seems to stand out as of great practical importance. According to Standfuss[34] the catching of insects by artificial scents yields to the lepidopterologist the richest harvest of fertilised, egg-laden females. We find here the reverse results to those obtained by catching insects with artificial light-traps, and we are inclined to think that in the same way as the females of different species only lay their eggs after they have been feeding, these egg-laden females are tempted to fly to their doom by the influence of some attractive scent similar to that of a favourite food of theirs or of other stimulating substances.

### The influence of external and internal factors on the development and life of insects.

It is almost needless to re-affirm here the very powerful influence which climatic and atmospheric conditions exercise upon insects. Yet how small is our positive knowledge of the physiological processes and changes which are continously proceeding in the organisation of growing and full-grown animals! It is quite clear that such influences must combine with the physiological conditions existing at the time in the organism, and that such combinations of external and internal factors are liable to produce the most varied results. If I were to enter exhaustively into these questions I could only do so in a voluminous work; hence I must confine myself here to making a few observations.

It is generally understood that a hot and dry summer has upon many insects—including the much dreaded grape-worm, *C. ambiguella*—a most destructive effect. Generally it is assumed that the eggs and larvae dry up, and this is undoubtedly true to a certain extent. But the heat alone may be sufficient to account for the sudden decrease and destruction of insect pests. Some years ago I[12] was experimenting in order to ascertain exactly at what temperature eggs and larvae of insects die; and further what physiological processes take place in connection therewith. Eggs and larvae in different stages of development were, while maintaining the necessary quantity of humidity, kept under various degrees of heat and then safely stored away. The results of these experiments led me to arrive at the following conclusions:

"The degree of heat which here comes into question is fairly constant and, which is specially interesting, somewhat low. Side by side with this, in

consequence of the action of these temperatures upon the organism, there are changes which demonstrate themselves in the coloration of the blood and which begin even at such low temperatures as 40°–41° C. with an exposure of 15 minutes. If the exposure at this temperature be prolonged to 40 minutes the insect larvae can still completely recover, but their ultimate survival becomes uncertain. There is no need here to pursue the application of these experiments to natural conditions, for such temperatures as we have utilised in the foregoing investigations occur everywhere in summer in the open. Their influence lies at the root of manifold changes depending upon local conditions."

I may be allowed to adduce an example in illustration of the effect of heat upon insects. A large number of larvae of the blow-fly, *Calliphora vomitoria*, which were ready for pupation, were kept for 70 minutes in a heat of 40–41° C. under appropriate conditions of humidity. Of the 196 larvae which survived that treatment only 53 became normal pupae, and of the latter 41 became flies. Under the influence of heat changes take place in the blood and these changes affect the tyrosinase contained therein, an oxydase which plays an important part in the pigmentation and metamorphosis of insects, as I have endeavoured to demonstrate in various publications bearing on that subject. These are enumerated in the bibliography under No. 10.

The cold of winter, on the other hand, when within normal limits, does not injuriously affect insects; in fact it rather promotes their future well-being. Only when cold occurs suddenly after mild temperatures or out of season does it become fatal to insects. On certain species however cold has a peculiar effect which is equally observable in normal winter time as in the colder regions of high mountains or in the Arctic regions. Such insects, and the females in particular, become wingless. This apterism is specially noticeable with Lepidoptera and Diptera of Alpine and of polar regions. The wingless state of the female of our winter-moth (*Cheimatobia brumata*) is well known, and the knowledge of this fact has given rise to the use of the glutinous belt which is fastened round fruit trees in order to prevent the wingless females from climbing up the trunks.

Insects may also be made wingless by artificially refrigerating their pupae and nymphae, a fact already recognised by several experimenters who have tried to produce colour changes in butterflies by means of high or low temperatures. Occasionally also bee-keepers have observed that after an abnormally severe winter the bees were wingless. I have occupied myself particularly with these phenomena and have come to the conclusion that wingless insects result only when cold is applied to pupae and nymphae. Cooling or heating of larvae yielded insects with normal wings. According to my interpretation of these observations the abnormal temperature would injuriously affect the oxydase (tyrosinase) which is found evenly distributed throughout the whole organisation of the larva but is concentrated in the wings of the pupa. If we take, for instance, a puparium of *Calliphora vomitoria* in which the still white pupa is enclosed and place it in alcohol, ether or chloroform, we obtain a white pupa with brown wings. Such however does not occur with previously boiled pupae, the enzyme therein having been destroyed by the high temperature.

Great humidity also quite unexpectedly influences the organism of insects. It is well known that the spun products of larvae have a certain practical importance in that they provide greater protection for the larvae and nymphae. Bataillon[1-3] and myself[6] have experimented on the spinning of insect larvae in a humid atmosphere. At various times I have ascertained that in such an atmosphere larvae, while transforming into pupae, abstain from spinning. It is thus possible to obtain nude pupae of species which normally produce pupae enclosed in a spun cocoon. I found further that if caterpillars of *Pieris brassicae* are placed on linen thoroughly saturated with water when the parasitic larvae of *Microgaster glomeratus* are just emerging from them, the larvae do not spin their cocoons, whereas under normal conditions they do so at once. Bataillon attributes these results to the fact that transformation can only take place under diminished osmotic pressure, to attain which the caterpillar or larva must rid its organism first of the silk fluid, then of the contents of its alimentary system, including all excreta, but finds itself impeded therein by humidity.

Bataillon[1-3] and myself[10] have also enquired into the influence of internal respiration on transformation; whereas Bataillon holds that the transformation of larvae is brought about by an accumulation of carbonic acid in the organism, I have endeavoured to prove that the oxidising enzymes are the main factor in bringing about the transformation. The indispensable effect of oxygen may be gathered from the observation that if adult larvae of flies are placed in a high cylindrical glass filled with earth, those which are on the surface will first undergo transformation, while of those in the soil the lowest are most retarded. On the other hand, if adult larvae of flies are put into small glass tubes from which all humidity is eliminated by using calcium chloride, they do not undergo any transformation at all; the same result being obtained if the larvae are placed in an atmosphere charged with hydrocyanic acid. With Lepidoptera the latter treatment produced also incomplete, soft-skinned, colourless pupae with only very short wings. The influence of the hydrocyanic acid gas consists in the reduction of the oxidising capacity of the tissues (*see* below).

Whosoever has bred insects will have remarked that certain species quit the egg or pupa at certain definite hours of the day. Occasionally reference is made to this fact, not only as regards insects, but also as applicable to other animals.

Recently I have closely watched for several weeks the spinning of caterpillars of *Lasiocampa quercus*. This caterpillar, like that of *Eriogaster lanestris*[15], forms its cocoon by spinning a fine, closely woven tissue which is saturated from inside by aid of the mouth, the caterpillar utilising therefor fluid, cream-coloured excreta extruded from the anus. When I opened in the morning, about 8 a.m., the tin boxes in which the caterpillars were kept, I regularly found silk cocoons. No caterpillars started spinning in the afternoon. Only after 2 and up to 4 p.m. the caterpillars set to work saturating the cocoon in the above manner. The backward ones completed their work only between 5 and 6 p.m. The cocoon, when quite dry, was incrusted with a hard mass.

This peculiar behaviour reminds me of the so-called "bird clock" or time of the day at which certain birds announce their waking up by emitting certain sounds; or of the "floral clock" of Linné which indicates the opening and closing of the

flowers of certain plants at certain fixed hours of the day. Perhaps one does not go wrong in attributing this punctual transformation and behaviour of insects and other animals to the relief which light gives to the tension in their tissues, as is also the case with the opening and closing of flowers. That leads us to a question of the highest interest, namely, of the effect of the seasons, and in that respect I should like to speak of a Physiology of the Seasons, of which autumn is particularly interesting. Numerous organisms, after having passed through various stages of development (eggs, pupae, gemmules of sponges, spores, bulbs, buds, etc.) then sink into a state of rest, and nothing, not even a raised temperature, can naturally interrupt that rest, until it terminates in its normal course. But we observe frequently—and many people look upon it as a freak of nature—that even late in autumn some trees blossom a second time and species of insects appear as if spring was approaching and not winter.

Occasionally specimens of the grape-moth, *C. ambiguella*, appear in the vineyards, and give rise to the fallacious hope of vineyard owners that the whole of that destructive insect pest would perish through the inclement weather and for want of food. I have frequently referred[14] to this subject in connection with *C. ambiguella* (Landwirtschaftl. Jahrbüch. Bd. 36, 1907, p. 983) and have ventured to express the hope that science and the inventive genius of man may yet succeed in finding means and ways for postponing artificially the general appearance of that most destructive insect from summer to late autumn, that is, to such a time of the year when climate and atmospheric conditions disastrously affect its existence.

In some cases the normal period of rest has already been successfully reduced by artificial means. The treatment of plants and flowers with ether or warm water, in order to promote artificially the more rapid formation of buds and flowers is well known to gardeners. Other instances concern lower animals. It is generally known how, by subjecting the eggs of the silk-worm in summer to a process of refrigeration the normal period of such rest is changed. Several experimenters have been well aware of this peculiarity and have more closely studied it, prominent amongst them being E. Duclaux (C. R. Acad. Sc. Paris, 1869, p 69 ; 1871, p. 73 ; 1876, p. 83). Italian investigators have since employed with success acids, electricity, etc. According to Weissmann[35] the period of rest of *Cladocera* is considerably shortened by temporary desiccation or refrigeration. Standfuss[34] succeeded in producing moths in autumn from insect pupae which normally hibernate, by applying to the latter abundant humidity after they had been kept for a long period in a very dry condition. When 200 to 400 pupae of *Saturnia* were kept 7 to 10 weeks (from June to end of September) in a very dry atmosphere and then thoroughly moistened a few times at short intervals, about 1 per cent. of such pupae emerged, which under normal conditions would not happen before the following May.

All these methods have one point in common, namely, that they cause loss of water in the tissues. Raph. Dubois,[18] who has written much about this expelling of water by means of cold, ether and other anaesthetics, has applied to these methods the word "atmolyse."

The autumn season produces also other notable effects upon insect life. During autumn males appear of many insects and other arthropods which are

parthenogenetic in spring or summer, and then non-sexual propagation gives way to sexual. Hence to speak of a physiology of the seasons is perhaps not so unjustified as it may appear. Who can doubt that the numerous species of insects which live and thrive on plants, in particular plant-lice, are vitally affected by the changes which autumn effects in plants.[2] The plant organism and its contents such as starch, sugar, albumen and enzymes differ greatly during the summer, autumn and winter seasons, and it is quite unthinkable that such material changes should be without effect upon the state of all the insects which feed upon them.

There is another problem which must prove highly interesting in relation to applied Entomology ; I mean the question of the determination of sex, which at present stands in the fore-front of biological research. And we see here plainly how intimately physiological and applied science are interwoven. Both, after all, occupy themselves with and revolve round cardinal questions of Life. Landois[26] reared caterpillars on both plentiful and scanty food and as the result of his observations concluded that plentiful feeding produced females and scanty food males. According to Seitz,[33] Treat and Th. Gentry support that view. But they have all clearly overlooked the fact that the sexes of insects are already fixed very early, indeed long before they are capable of taking any food whatsoever. Standfuss[34] interprets the matter by pointing out that male caterpillars are better able to survive bad nourishment than females ; hence that in the end more males survive. One may also connect herewith the observation that the proportion of sexes can change in so far that when a great invasion is decreasing, the males are much more numerous than when the invasion was at its height. This may be the result of the bad condition of the food-plants, or it may more likely be due to changes in the organism. For we find ourselves here facing only the external signs of the main causes of the difference of the sexes, the real nature of which is still unknown to us.

## The physiological effects of insecticides.

We are rather ignorant yet regarding the physiological processes which go on in the bodies of insects in consequence of insecticides ; and although new insecticides continue to be placed on the market and are being used, the question of their physiological effect is rarely asked, far less has it been satisfactorily answered. Pharmacology as an integral part of Insect Pest Research does not yet exist! Vague definitions of "stomach" or "contact" poisons are doing service instead. Probably few of those who have used hydrocyanic acid for the destruction of insect pests have been aware of the physiological effect of that poison on the animal organism. Cl. Bernard has observed that on injecting hydrocyanic acid into the blood-vessels of mammalia a flow of red, arterial blood issued from the veins. Geppert[22] followed up this observation and found that by injecting hydrocyanic acid into blood-vessels the tissues of the body lose their faculty for absorbing oxygen, hence the animal dies of suffocation, in spite of abundance of aerial oxygen. For more than 12 years I have occupied myself with this question and at the International Congress of Agriculture in Paris (1900), Section for Plant Pathology,[8, 10] I stated that caterpillars cannot fully develop in an atmosphere charged with hydrocyanic acid.

As previously mentioned, adult caterpillars of *Porthesia chrysorrhoea*, while in process of transformation, were put into an atmosphere containing hydrocyanic acid gas and resulted only in pupae with very small wings, devoid of chitin, and of colourless body, all indications which are likewise present as a result of want of oxygen.

"Contact" liquid insecticides have in a similar way been accepted and generally used without any questions being asked as to the nature and basis of their efficiency. It was generally asserted and assumed that the "contact" liquid penetrates into the tracheae, thereby suffocating the insect. Microscopical examination reveals the fact that liquid does penetrate into the tracheae; but such penetration is in most cases so very incomplete that it cannot possibly be accepted as causing the insect to perish by suffocation. Moreover there are numerous "contact" insecticides in the form of powder, and surely no one can believe that their efficacy consists in filling the tracheae and choking the insect. The stigmata of insects are far too small to permit of this and they are frequently protected in a special manner. I am rather inclined to believe that contact insecticides, both liquid and as powder, have a fatal effect upon the sense organs of insects.[13] Fujitani's[19] statement that the active agent of Pyrethrum is a nerve and muscle poison, to which fishes and insects are very sensitive, will go far to confirm my view.

It is somewhat early to speak of the influence of sucking insects on plant organs in the sense of the effect of enzymes of fungi on them, although a few observations thereon are known. But in view of our present knowledge of enzymes and toxins it would be futile to deny a direct chemical action of all sucking insects upon plant organs. Why should not the puncture of an *Aphis* or of a *Phylloxera*, which thereby transforms the organ of the plant, transfer toxic substances into the plant tissues in the same way that the sting of a scorpion or of a bee introduces toxins into the organism of man or other animals?

If the above comments and tentative intimations on only a few entomological and physiological subjects of general interest, which are familiar to me, contribute to bring home only a part of the important bearing of physiological research upon Applied Entomology, we shall come nearer to the time when physiology will occupy that eminent place in connection with insect pest research which, by its very nature and intrinsic value, it should hold.

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# ON THE CHARACTERISTICS OF THE NEWLY DISCOVERED TSETSE-FLY, GLOSSINA AUSTENI, NEWSTEAD; WITH DESCRIPTIONS OF THE GENITAL ARMATURE OF GLOSSINA FUSCIPLEURIS, AUSTEN, AND GLOSSINA LONGIPENNIS, CORTI.

By Professor R. Newstead, F.R.S.,

*The Liverpool School of Tropical Medicine.*

In pursuing my studies of the genital armature of the tsetse-flies, I have been fortunate in securing some valuable and interesting material from various parts of the African continent which has enabled me to offer a further contribution on the specific characters of the recently discovered *Glossina austeni*, Newst., from British East Africa; to present a detailed account of the armature of the apparently rare *G. fuscipleuris*, Aust., and to clear up some doubtful points in regard to the structural details of the male genital armature in *G. longipennis*, Corti. Later I hope to be able to offer some further remarks on *G. palpalis*, R.D., especially in regard to the colour and structural variations existing in this species. Meanwhile I may here state, for the guidance of the student, that *G. fuscipes*, Newst., which was described by me as a distinct species, must sink as a well-marked race of *G. palpalis*.

## **Glossina austeni,** Newst.

*G. austeni*, Newstead, Ann. Trop. Med. and Parasit., vol. vi, no. 1B., pp. 129–130 (May 1912).

The distinguishing characters of this insect are its small and slender form; the relatively narrow head; the presence of a more or less clearly defined dark bilateral stripe on the thorax; the *bright ochraceous or reddish-ochraceous abdomen*, with its dark lateral markings, or interrupted bands; the dark hind tarsi; and, in the male, the *foot-like shape of the superior claspers* (fig. 1, *sc*) and the narrowly pointed, distal portion of the harpes (fig. 1, *h*).

Though possessing dark hind tarsi this insect must undoubtedly be placed in the "*morsitans*-group" of the tsetse-flies, as the morphological characters of the male genital armature show very clearly that it is related to the insects comprised in this group. Of the species possessing dark hind tarsi the only one with which *G. austeni* can possibly be confused is *G. tachinoides*. Both are small and slenderly built insects, but the former may be distinguished at once by its narrower front, especially in the male, and also, as already stated, by the bright colour* of the abdomen and the presence of the dark lateral stripes on the thorax. In the original description of *G. austeni* (*l.c.*) I stated that the insect "bears a somewhat close resemblance to a dwarfed specimen of *G. fusca*." Now that I have a long series before me I feel that this statement cannot hold

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* Mr. Neave, who has seen examples of this insect in life, informs me that it is readily distinguished from all other tsetse-flies by its reddish colour.

good, as the general colour of the abdomen, though a shade brighter, is most like that of *G. longipennis.* I append below a further description of *G. austeni.*

*Head* buff, relatively narrow, posterior surface usually faintly greenish grey; frontal stripe varying between warm buff and dusky red-brown. Third segment of antennae buff, with the apical two-thirds, or apex only, infuscated. Palpi ochreous buff, infuscated distally. Proboscis bulb ochraceous buff, with or without median infuscation.

*Thorax* dusky buff, tawny ochraceous or faintly isabella-coloured; the usual dark brown or blackish markings forming a more or less distinct, broad bilateral stripe which, under a low magnification, is seen to be composed of three well-marked areas: a small but well-defined triangular or roughly crescentic spot in front, near the humeral callus; and two much larger spots or areas divided by the narrow pale transverse suture and outlined laterally by a very clear and sharply defined margin. The two dark narrow admedian stripes are often present, and when continued behind the transverse suture their ends diverge; in some instances the stripes unite and form a relatively broad median one; or they may be entirely wanting, especially in the males.

*Legs* pale ochreous buff; front femora often with a faint infuscated patch on the inner surface distally; hairs on the front, middle and hind coxae all black; tips of last two segments of front and middle tarsi very narrowly darker, but sometimes the dark colour is absent in the former; all the segments of the hind tarsi dark, but the last two segments are often darker than the rest.

*Abdomen*: dorsum bright ochraceous, reddish ochreous or yellowish buff; second segment usually with a small dark brown blotch near the anterior lateral angle; third and fourth segments with a larger dark brown blotch (sometimes quite indistinct or altogether wanting) not reaching to the hind margin; fifth and sixth segments more or less uniformly infuscated, but paler medially, or with interrupted bands; in some examples the second to the sixth segments, inclusive, have clove-brown or dark brown, *interrupted* bands, similar to those in *G. longipalpis*, though not so clearly defined; seventh segment in female uniformly dark brown or clove-brown.

*Wings* without any marked infuscations.

*Genital armature of the male* (fig. 1). Superior claspers (*sc*) united by the dorsal spinose membrane and fused medially as in *G. morsitans* and other members of the "*morsitans*-group"; form resembling somewhat the outline of a human foot in minature, outer lateral projection strongly produced and narrowly rounded, but without a blunt tooth-like process as in *G. longipalpis*; distal margin between the outer lateral projection or heel-like extension and the medial lobes furnished with a fringe of short stiff spines, which unite with the series on the inner lateral margin, where they gradually lengthen and proximally form a more or less compact group; median lobes (*ml*) relatively very large and broadly rounded, forming the toe-like extension of the clasper; the long marginal hairs arranged in two pairs distally, the single sub-terminal one projecting backwards. Long hairs of the editum (*e*) scarcely reaching the lateral hairs of the superior claspers. Harpes (*h*) *pointed and narrowly triangular* in outline dorsally, but ventrally there is an outwardly curved process (*see* dotted line, fig. 1 *h*); outer lateral surface clothed with

fine erect hairs; proximal lobe-like extensions divergent and broadly rounded. Juxta (*j*) relatively much narrower distally than in *G. longipalpis*, and of a similar form to that of *G. morsitans*. Hectors with the black spines narrowly but clearly divided medially.

The first and only example, a female, was submitted to me for identification by Mr. R. P. Filleul, Assistant District Commissioner at Alexandra, Gorha, Jubaland, British East Africa; under date March 17th, 1912. This specimen formed the type of the original diagnosis given by me in the Annals of the Liverpool School of Tropical Medicine (*l.c.*). Recently Mr. Filleul has

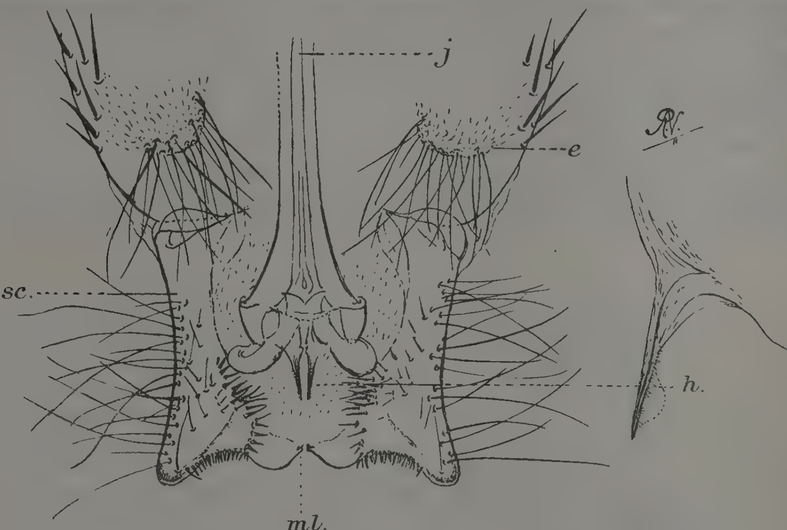


Fig. 1.—Male armature of *Glossina austeni*, Newst.

very kindly forwarded a series of 22 specimens of this tsetse-fly of which 8 are males and 14 are females, all in an excellent state of preservation. He also furnished me with the following particulars regarding his captures:

"I am glad this small fellow you call *austeni* is of interest to you. I have just been on 'safari' to the northern part of my District and send you my catch. I found them in the same localities with *G. pallidipes* and *G. brevipalpis*, the proportions being *pallidipes* 150, *austeni* 20, *brevipalpis* 5. I regret I do not know the classical names of the trees, but perhaps the following will assist. Jubaland is apparently all alluvial soil, chiefly the extremely fertile black cotton soil, but owing to lack of rain-fall and irrigation it is only cultivated by the Wagosha in primitive fashion along the river banks, where the forest has been felled. There are occasional swamps or deshehs, as they are called in Somali, which are filled up by the floods in November or October and are dry for the most part by the following June. The river banks and the edges of the deshehs are covered with forest. Amongst the trees are Dane Palms, Sycamore Figs, Candelabra trees [Euphorbias], &c. The specimens enclosed were all caught within $\frac{1}{2}$ mile of water.

"I notice that *G. pallidipes* prefers to bite low down, and that *G. austeni* bites high up. The latter are considered specially deadly to cattle. All the insects were caught in longitude 42° 48′ between 0° 43′ and 0° 55′ N. latitude, approximately. In May last year (1911) I saw the first small *austeni* in the garden here, and when Dr. Chevallier came up later I told him about it and said he ought to make a search, accordingly on his way up the river he did so and got a specimen, in the meantime I got two also."

I have nothing to add to Mr. Filleul's communication regarding the bionomics of *G. austeni*, though I have pleasure in stating that this species was dedicated, by kind permission, to Mr. E. E. Austen of the British Museum, in recognition of his great work in connection with these insects, and also as a token of esteem and regard.

## Glossina fuscipleuris, Aust.

*G. fuscipleuris*, Austen, Handbook of the Tsetse-flies, p. 75 (1911).

*Genital armature of the male* (fig. 2).—Superior claspers (*sc*) very stout; apices toothed and as in the other species of the "*fusca*-group" these appendages are free and not united by a membrane. Harpes (*h*) each with *three* very long

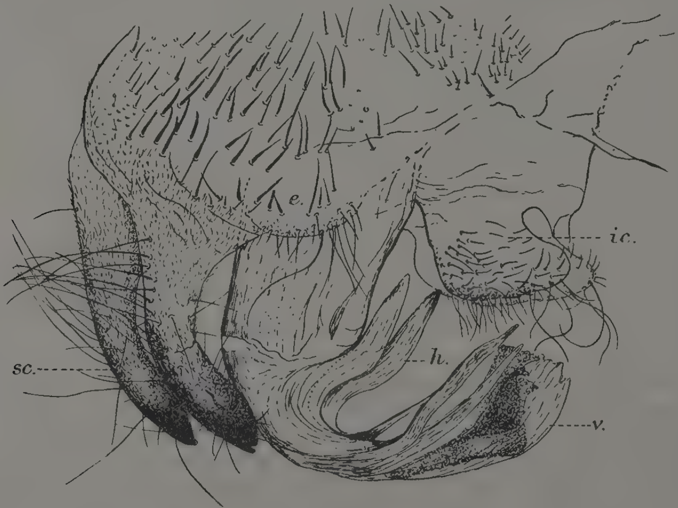


Fig. 2.—Male armature of *Glossina fuscipleuris*, Aust.

processes; the proximal pair are highly chitinised, broad and somewhat lanceolate, with the upper edge coarsely and irregularly serrate, the proximal half strongly curved; the second pair of appendages or processes are extremely narrow, especially the distal two-thirds, base slightly dilated and much more highly chitinised than the rest, apices hidden beneath the next pair of processes; third pair very long and much narrower than the proximal pair, being also more or less ribbon-like, with the distal portion decidedly narrower. Vesica (*v*) with two large dark-coloured chitinous sclerites. Inferior claspers (*ic*) normal.

The armature of this tsetse-fly bears some resemblance to that of *Glossina tabaniformis*, Westw., but it is abundantly distinct from this or any other species. The distinguishing characters are: that the harpes have three processes instead of four, as in *G. tabaniformis;* the great width and the serrations of the proximal pair; the extreme narrowness of the second pair; and the ribbon-like character of the third pair. Another distinguishing feature also is the great size of the sclerite in the vesica.

This description is based upon an example in the collection of the Liverpool School of Tropical Medicine which bears the simple data "Congo Free State." There can be no possible doubt as to the identity of the species as, through the courtesy of Mr. E. E. Austen, I have been able to examine the male genital armature of his type specimen in the British Museum, and I find that it agrees in all its morphological details with that of our example. Furthermore, I am indebted to Dr. H. Schouteden for giving me the opportunity of examining the only other example known at present, which is now in the collections of the Musée Congo Belge. I may add also that the last-named specimen was captured in the same region of the Congo Free State as that in which Mr. Austen's type was discovered.

### **Glossina longipennis**, Corti.

In my former description of the armature of the male of this species* I was unable to give a full account of the various structures owing to the fact that my specimens were mounted so that only a dorso-ventral view of them was possible. Now that I have succeeded in obtaining another example of this tsetse-fly the armature has been mounted so that it can be examined in profile and thereby a more correct interpretation of the various structures, and also the relationship which they bear to the "*fusca*-group," has been rendered possible. It may be readily seen on comparing the illustration (fig. 3) with those of other members of this group that the morphological characters are markedly distinct and quite unique.

The description herein appended and also the accompanying illustration have been drawn up from an example kindly presented by the Entomological Research Committee, to whom I am greatly indebted. The following data were attached to this specimen: Tana River, British East Africa, 1911.

*Genital armature of the male* (fig. 3).—The superior claspers (*sc*) appear much more slender when seen in profile than dorso-ventrally; the apices are also much more falcate. The harpes (*h* 1, 2) consist of two pairs of appendages; the basal or proximal pair (*h* 1) are very large, sub-quadrate in outline, with a depression on the distal margin, which gives them a bilobed appearance in examples which have been completely dissected out (*vide* Bull. Ent. Res. II, p. 21, fig. 8*h*), and furthermore they are covered with large squamose spines; the distal processes (*h* 2) are long, slightly dilated proximally, narrow and strongly recurved distally, being also rather widely separated from the broad spinose appendages basally. The median process (*mp*) occupies a unique position, in that it lies between the spinose harpes, while in the other members of this group it originates between the inferior

* Bull. Ent. Res. II, p. 21 (1911).

claspers; it is long and narrow, though strongly dilated basally, the distal portion reaching to the upper margin of the harpes. Vesica ($v$) almost entirely membranous and without any marked subcutaneous sclerites. Inferior claspers ($ic$) small, rounded apically and relatively very narrow; they are widely separated from the median process and consequently placed much nearer the articulation of the hypopygium than in the other species of *Glossina*.

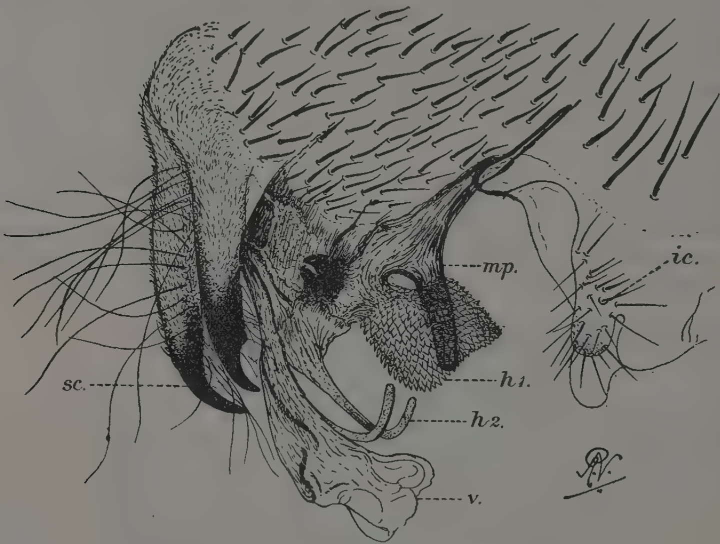


Fig. 3.—Male armature of *Glossina longipennis*, Corti.

Unfortunately the editum is so much obscured by the folded nature of the integument which surrounds it that it has not been possible to give an illustration of it in the figure given in the text; but so far as one can judge it does not differ from those of the other allied species. It is important to add also that the left spinose harpe was displaced during the process of mounting and is not therefore shown in the illustration. Normally these appendages lie exactly in opposition, and as they occupy different planes the elimination of one of them is not likely to mislead future investigators.

[In addition to the specimens of *Glossina austeni* recorded by Mr. S. A. Neave in the last part of this Bulletin (p. 306), the Entomological Research Committee has since received further examples taken on Juba River, ix. and x. 1911 (*Dr. C. L. Chevallier*), and 2 ♂♂ and 1 ♀ from so far south as Portuguese East Africa (*H. L. Jones*).—Ed.]

# NOTES ON PHLEBOTOMUS, WITH DESCRIPTIONS OF NEW SPECIES—PART I.

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In making a critical examination of the palpi of the various species of *Phlebotomus* described in this paper, I have found that the third* segment of the palpi in all of them is provided with a compound group of minute and curiously modified spines. In *P. minutus* (fig. 1*c*) they are somewhat squamiform and the

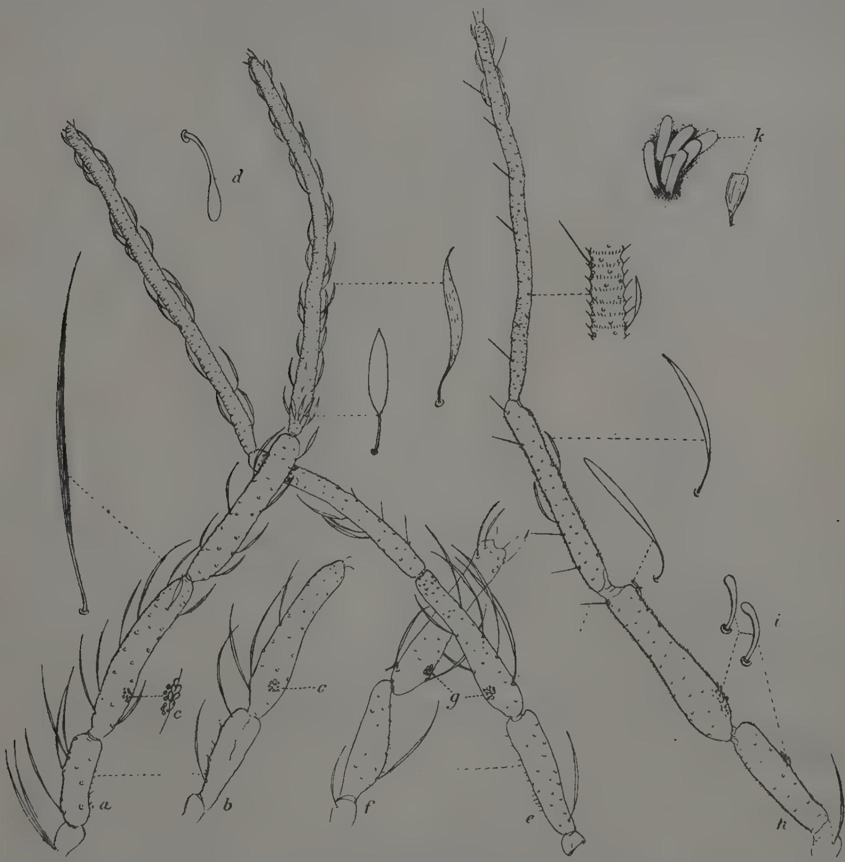


**Fig. 1.—Palpi of *Phlebotomus*.**

*a*, Palpus of *P. minutus*, Rond., ♂, dorsal view ; *b*, basal segments of the same, lateral view ; *c*, modified spines ; *d*, a similar spine from palpus of *P. papatasii*, Scop. ; *e*, palpus of *P. minutus* var. *africanus*, Newst., ♂, dorsal view ; *f*, basal segments of the same, lateral view ; *g*, modified spines ; *h*, palpus of P. *squamipleuris*, Newst., ♀ ; *i*, modified spines ; *k*, mosquito-like scales on pleurae of P. *squamipleuris*.

* In *P. squamipleuris* they occur on the second segment also ; but I find no trace of them on the corresponding segments in the other species. R.N.

pedicel is, so far as I can ascertain, extremely short; in *P. papatasii* (fig. 1*d*) they are distinctly spathuliform, with the pedicel long and strongly curved. In *P. squamipleuris* (fig. 1*i*) the spines are similar to those found in *P. papatasii*, but they appear to be more gradually dilated distally and have relatively shorter pedicels. These organs are common to both sexes and are probably sensory in function; but they are so easily deciduous that they can rarely be seen, though the position occupied by them is generally indicated by a compound group of circular cicatrices clearly showing the point of attachment of the spines with the integument.

I have also discovered the presence of hirsute glands (fig. 2*c*) in the antennae of both sexes in all of the species, with the exception of *P. antennatus*, sp. nov.


Fig. 2.—Antennae of *Phlebotomus*.

*a* and *b*, proximal and distal segments respectively of antenna of *P. minutus*. Rond., ♀; *c*, hirsute glands; *d* and *e*, distal and proximal segments respectively of antenna of *P. antennatus*, Newst.

(fig. 2 *d*, *e*). They are, so far as I can ascertain, present only on the last three segments, but are rarely visible on the terminal one. In optical section they appear crateriform in shape and the lip is fringed with fine hairs. It is impossible, without cutting sections of these organs, to add any further particulars regarding them, and, in the absence of properly fixed material, this cannot be done at the present juncture.

The method adopted in preparing these insects for microscopical examination was precisely the same as that which was described by me in this Bulletin (Vol. II, p. 13). Staining is essential, as thereby the wing venation and the minute structural characters are much more clearly defined. In submitting

specimens for identification they should, by preference, be placed in a strong shallow pill-box *on* a web-like layer of cotton wool, but it is fatal to place a second stratum of such material above the insects as it not only flattens the specimens, but also breaks off the appendages and thus renders them useless for study. If the cotton wool is teased out so that the strands are loosened the insects will adhere to this, and will thus be prevented from becoming abraded during transit. Pinning such minute insects often renders them valueless for microscopical study, and moreover it is rarely that specimens so treated can be determined with any degree of accuracy owing to the minute differences which exist in this small and obscure group of insects. If pill-boxes are used, they must necessarily be placed in a stronger box for transit.

One of the most interesting instances of geographical distribution among these apparently frail midges is that of *Phlebotomus minutus*, Rond. The true form, so far as one can judge, is found not only in the Mediterranean area, but also in India, while the African race (var. *africanus*, var. nov.) occurs in such widely separated regions as the Anglo-Egyptian Sudan, British Central Africa and British West Africa. It is probable that, as we extend our studies of these flies, the var. *africanus* may eventually be given specific rank, but I must admit that the separation of the typical form from this variety is a critical and difficult task, all the more so as the latter is given to considerable variation in size, a marked variation in the length of the terminal segments of the palpi and in the form of the wings (*see* fig. 3 *a*, *b*).

## **Phlebotomus minutus**, Rondani.

Having examined two additional examples of the species (both from Malta) since the publication of my paper* dealing with the Papataci Flies of the Maltese Islands, I find that the character of the third segment of the palpi varies considerably according to its orientation and that when seen dorsoventrally (fig. 1*a*) there is little or no trace of the incrassation noted by me, though when seen in profile (fig. 1*b*) this segment is considerably wider than the preceding one, and thus I was led to believe that it was distinctly swollen on all sides. After re-examining all my material, I have come to the conclusion that the segment in question is flattened or depressed laterally, and that its transverse diameter is much less than that of the vertical diameter.

I have pleasure in recording the occurrence of this species at Suda Island, where 1 ♂ and 2 ♀♀ were taken by Fleet-Surgeon Lancelot Kilroy (H.M.S. Diana), 30.x.1910.

## **Phlebotomus minutus** var. **africanus**, var. nov.

*Length* (average), 2·25 mm.; largest wing, ♀ 2·28 mm., ♂ 1·95 mm.; smallest wing, ♀ 1·78 mm., ♂ 1·33 mm.

This is clearly a well defined race of *Phlebotomus minutus*, Rond., differing in the relatively longer second and fourth segments of the palpi (fig. 1, *e*) in both

* Bull. Ent. Res. II, p. 69 (1911).

sexes, and in its more pointed wings (fig. 3 *a*, *b*). It is also, as a rule, larger, but there is a marked range of variation in size, so that this character alone cannot be taken as a guide to its identification. It is moreover generally darker than typical *P. minutus*, but in all other respects, including the structural details of the male genital armature it is inseparable from the latter. It may be noteworthy to add that Annandale* has described a variety of *P. minutus*, Rond., from India under the name *niger*, and says that it is "darker than the typical form and as a rule larger," though he failed to "distinguish any constant difference in its venation or genitalia." No reference is made to the structural characters of the palpi, neither has he noted any difference in the form of the wing. I am forced to the conclusion, therefore, that the African race is not synonymous with the var. *niger*, of Annandale.


Fig. 3.—Wings of *Phlebotomus* : *a*, *P. minutus* var. *africanus*, Newst., ♂ ; *b*, the same, small form, ♂ ; *c*, *P. minutus*, Rond., ♂.

MALE. Colour generally much more dusky than that of typical examples of *P. minutus*, Rond. Upper portion of thorax and abdomen pale smoky-brown ; thoracic hairs erect, dusky greyish, with brownish tips ; abdominal hairs on first and second segments long and erect, forming two small tufts dorsally ; remaining hairs shorter, recumbent and generally uniformly dark brown, being usually much darker than the integument. Wing fringe generally smoky grey with an admixture of darker hairs.

*Proboscis* very slightly shorter than the head, inclusive of the clypeus. *Palpi* (fig. 1 *e*, *f*) with the segments 2 to 4, inclusive, each successively longer ; second segment one-third to one-fourth longer than the third ; fifth very variable in length, but usually three to three and a half times the length of the second. *Antennae* with the third and fourth segments relatively shorter than those in *P. minutus*. *Wings* (fig. 3 *a*, *b*) lanceolate and markedly pointed ; tip of first longitudinal vein either opposite to, or considerably in advance of, the anterior fork of the second longitudinal vein, so that this character is given to great variation.

* Rec. Ind. Mus., IV, p. 320 (1911).

FEMALE. *Palpi* with all the segments usually slightly shorter than those of the male.

GOLD COAST: Salaga, 1911, 1 ♂, 3 ♀♀ (*Dr. G. E. H. Le Fanu*).

SOUTHERN NIGERIA: Onitsha, 5–8. viii. 1910, 6 ♀♀ (*Dr. J. J. Simpson*).

NORTHERN NIGERIA: Baro, 15. x. 1910, 1 ♂ (*Dr. J. J. Simpson*).

ANGLO-EGYPTIAN SUDAN: Tokar, Red Sea Province, iv. 1911 (*H. H. King*).

NORTH EASTERN RHODESIA: the type and other examples were taken by *Mr. S. A. Neave* in the following localities:—Mid Luangwa River, 30. viii. 1910, 2 ♂♂; Lower Luangwa River, 5. ix. 1910, 1 ♂; on the road between Petauke and Chutika's Luangwa Valley, 16. ix. 1910, 2 ♂♂; Niamadzi River, 19 and 21. vii. 1910, 3 ♂♂; junction of Mpamadzi and Luangwa, 24. viii. 1910, 2 ♂♂, 1 ♀; Mpamadzi River, Luangwa Valley, 23. viii. 1910, 1 ♂, 1 ♀.

NYASALAND: Chitala stream, 10 miles west of Domira Bay, 22–28. x. 1910, 1 ♀ (*S. A. Neave*); near Lake Malombe, Upper Shire River, 4. viii. 1911, 1 ♂; 9. viii. 11, 1 ♀; 29. ix. 11, 1 ♀ (*R. Newstead* and *Dr. J. B. Davey*, Sleeping Sickness Commission.)

The examples herein recorded from Nyasaland by Dr. Davey and myself were all taken inside our tents during the day-time. Had these insects been more conspicuous other examples could no doubt have been secured; but pressure of other official work prevented us from making a more thorough search for them. Their presence at night was indicated by the feeble mosquito-like sound which they produced when hovering around one's face under the mosquito curtain; but their visits to our camp at night were markedly few during the months of July to September, inclusive, so that at this season they evidently occur in small numbers.

**Phlebotomus antennatus**, sp. nov.

*Length*, 2·35 mm.; wing 1·4 mm.

This species may be distinguished at once by the short stout form of the antennal segments, of which the third to the thirteenth, inclusive, are much more bead-like than those of any other species which has hitherto been described. Furthermore, it may be distinguished from *P. minutus* var. *africanus*, by its shorter and stouter legs.

FEMALE. Colour and arrangement of the hairs on the head, thorax and abdomen somewhat doubtful, owing to the rubbed condition of the specimen, but their arrangement appears to be the same as in *P. minutus*.

*Antennae* (fig. 2 *d*, *e*) with all the segments, unusually short and stout; the third scarcely one-third longer than the fourth; the thirteenth segment only very slightly longer than the succeeding one; the paired and geniculated spines are present on the third to the fifteenth segments, inclusive; the hirsute glands, seen so clearly in other species, not traceable, and if present, they are apparently quite rudimentary. The long hairs on all of the segments decidedly scattered and not so much confined to the proximal portions as is usually the case. *Palpi:* second to fourth segments, inclusive, like those of *P. minutus*, including also the compound groups of spines upon the proximal portion of the third

segment; length of terminal segment doubtful, as one of them is wanting and the other is rendered partly obscure by the superimposed legs, though it is apparently shorter than the corresponding segment in *P. minutus*. *Legs* relatively short and stout. *Wings* similar to those of *P. minutus*, but all the veins are relatively stouter.

GOLD COAST: Salaga, 1911.

The type and only example* was collected by *Dr. G. E. H. Le Fanu*, to whom I extend my thanks for giving me the opportunity of examining and describing this interesting new species.

## Phlebotomus squamipleuris, sp. nov.

*Length*, 2·65 mm.; wing, 1·84 mm.

FEMALE. Pleurae *clothed with large flat mosquito-like scales* (fig. 1*k*). This character alone readily distinguishes this insect from all the other known members of the genus. *Colour:* integument dull brown (possibly a very variable character in museum specimens). Head and thorax densely hairy, the hairs dusky grey; abdominal hairs recumbent and similar in colour to those on the thorax; they are, however, somewhat sparse. Wings beautifully hyaline and, in certain lights, the hairs on the fourth longitudinal vein golden iridescent; fringe greyish, posteriorly very long and dense. *Head*, inclusive of clypeus, equal in length to the proboscis, the latter, especially the labium, somewhat slender. *Palpi* (fig. 1*h*) very long and somewhat slender; third segment one-sixth longer than the second; fourth scarcely longer than the third; fifth scarcely twice the length of the fourth; segments 2–4 inclusive without any marked incrassation; some of the few remaining scales which clothe the palpi are of great size and broadly lanceolate, but for the most part these organs are denuded in the microscopical preparation. *Antennae*, with the exception of the first two segments, wanting, but those which remain are somewhat thickly clothed with minute, short hairs. Legs long but fairly stout; anterior and mid trochanters spinose, the spines short and arranged in groups. Wings decidedly narrow, much more so than in the female of *P. papatasii*.

ANGLO-EGYPTIAN SUDAN: Khartoum, 7 and 8.viii.10, 2 ♀♀ (*H. H. King*).

## Phlebotomus papatasii, (Scopoli).

This species has been received from the following localities:—ANGLO-EGYPTIAN SUDAN: Tokar, Red Sea Province, 1912: 8 ♂♂, 12 ♀♀ (*H. H. King*). EGYPT: Cairo (*F. C. Willcocks*).

## Phlebotomus duboscqui, N.-L.

*Phlebotomus duboscqui*, Neveu-Lemaire, Bull. Soc. Zool. de France, XXXI, p. 65, figs. 1–3 (1906).

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* I have recently discovered a small glass tube containing several additional examples of this insect (all ♀♀). They bear the data: "Caught in sheltered spots of bedroom; Salaga, Gold Coast, West Africa, 19th June 1911, Dr. G. E. H. Le Fanu."

This species was originally found at Hombori in the French Sudan in May, 1905. Austen* records its occurrence also at Bekwai in Ashanti, and on the Cross River, but expressed the doubt as to his examples being specifically identical with *P. duboscqi.*

Though I have not been able to examine specimens of this species I gather from Neveu-Lemaire's description and figures that his *P. duboscqi* is not only very clearly distinct from any other known species of *Phlebotomus*, but that it is unique in two respects, namely : the terminal segment of the palpi in the female is shown as being slightly *shorter than the sub-terminal one*, and the antennae in the same sex are stated to consist of *13 segments as against 16 in all the other known species*, so that in view of these marked characteristics there should be no difficulty in recognising *P. duboscqi.*

If the armature alone may be taken as a guide to its relationship with the other African species, then it is clearly related to *P. papatasii*, as is shown by Neveu-Lemaire's illustration (fig. 3), in which the form of the superior clasper appears to be specifically identical. Clearly, therefore, *P. duboscqi* is, in this respect, quite unlike *P. minutus*, Rond., or any of the other smaller species of this genus inhabiting Africa.

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* Austen, African Blood Sucking Flies, p. 20 (1909).

# ON TWO NEW PARASITIC ACARI OF THE GENUS LEIOGNATHUS, CN. (GAMASIDAE).

By S. Hirst.

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Most of the species of *Leiognathus* are parasitic on small mammals (bats, rodents, etc.), others occur on birds and a few also on reptiles. A number of the species of this genus have been described under the name *Liponyssus*, but personally I do not think that *Liponyssus setosus*, Kolenati (the type and first described species of the genus *Liponyssus*) falls into the same natural genus as the species described by recent authors under that generic name or under the name *Leiognathus*. On the other hand, Kolenati's genera *Ischoronyssus*, *Macronyssus*, *Lepronyssus*, *Steatonyssus* and *Pimelonyssus* certainly seem to me to be congeneric with *Leiognathus*, Cn., and ultimately one of these names will have to replace Canestrini's.

## **Leiognathus creightoni**, sp. nov. (fig. 1).

♀. *Body* elongate oval in shape; some distance in front of the middle it is slightly constricted, the part of the body posterior to this constriction being wider than the front part of it. The setae at the posterior end of the body are rather long. *Scutum* (dorsal plate) large and rather wide, but it leaves a considerable portion of the dorsal surface uncovered, especially at the posterior end of the body (for its shape see fig. 1). A faint transverse line runs across the scutum near the middle and it is possible, therefore, that it consists of two practically fused shields in this species. A number of setae of moderate length are present on its surface, eleven of them being arranged in a longitudinal series on each side of it and these lateral setae have rather large sockets. *Ventral surface*: sternal plate large; it is wider than long and bears three pairs of bristles. Immediately behind the genital operculum, there is a rather weakly chitinised plate, which has a short seta on each side of it; the posterior end of this plate is not angular but rounded off. Anal plate pear-shaped, its posterior end being pointed and finely striated; the three usual setae are present on its surface. *Peritreme* rather short, for its anterior end is situated nearly opposite (slightly in front of) the coxa of the third leg. *Chelicerae* long; their digits long, slender and apparently without any teeth on their edges. *Legs* 4, 1, 3, 2; second and third legs considerably shorter than the others. First leg stout, the other legs more slender. Dorsal surface of anterior legs furnished with several long setae. Coxa of first leg armed with a conical spur on the inner side below. Coxa of second leg with a very large hook-shaped spur on its posterior side below and this spur bears a large tooth; on its anterior surface the second coxa has a dorsal spur, which points forwards. Third coxa with two conical spurs on its posterior surface. Fourth coxa with a single posterior spur. The first leg has also a number of short but stout teeth or spinules on its ventral surface;

two of them being situated on its trochanter, one on the femur, and two on the tibia, placed close together; a single minute spinule is also present on the metatarsus. The trochanter of the third leg has a minute ventral spinule. Tarsus of second leg with a pair of very minute denticles or spurs at its apex below. Tarsi of third and fourth legs each with a single apical spine below. *Colour* (in glycerine, diluted with water) a pale yellowish tint. *Length* ·87 mm.

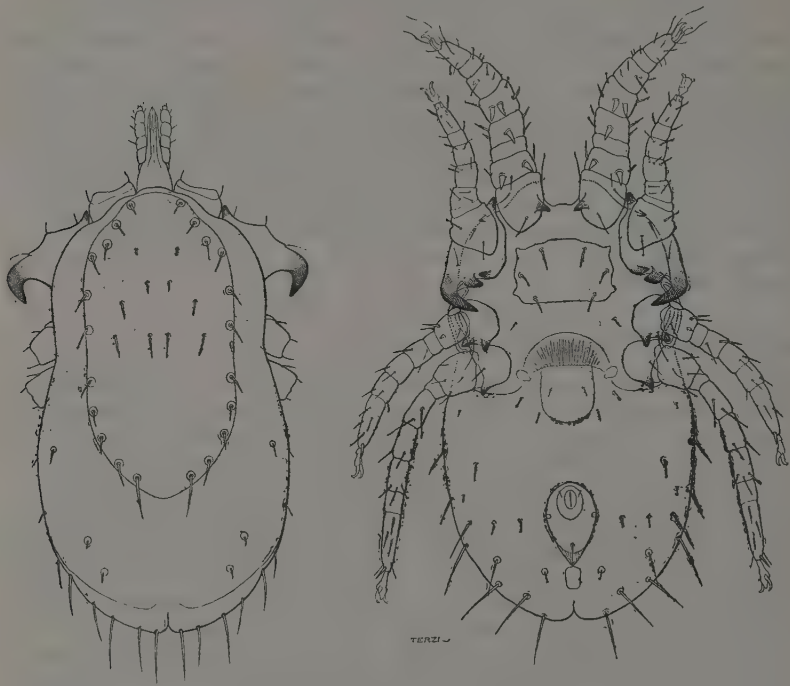


Fig. 1.—*Leiognathus creightoni*, Hirst, ♀, dorsal and ventral aspects.

This species was found by Mr. J. H. Creighton on a young porcupine captured at Nairobi, British East Africa, on January 15th, 1912. Mr. Creighton states in his letter, accompanying the specimens, that they "simply swarmed on the porcupine" and that "the native who skinned it complained that these parasites bit or stung him like a bee, but no mark or inflammation was left."*

* It is interesting to note that this is not the only case in which mites of this genus have attacked human beings. Mr. Nathan Banks has described and figured a species (under the name *Liponyssus americanus*) which he states was found on the arm of a person at Washington, D.C. Mr. G. A. K. Marshall has kindly lent me for examination some specimens of another species of *Leiognathus* found by Dr. W. M. Aders on human beings at Zanzibar. This species was received too late for incorporation in the present note, and I hope to deal with it in a subsequent paper on Acari.

The very large hook-shaped spur which is present on the second coxa is the most noticeable feature of the species described above. It is also characterised by the shape of the scutum and other plates of the body, the number and arrangement of the setae of the scutum, the shape of the peritreme, etc.

## **Leiognathus liberiensis**, sp. nov. (fig. 2).

*Body* much less elongated than that of *L. creightoni*, sp. nov., and much wider behind than in front. There are no long hairs at the posterior end of the body, all the hairs being short. *Scutum* undivided ; in shape it is rather like that of *L. creightoni*, but is narrower; the hairs on its surface are very minute. *Ventral surface.* Sternal plate large and furnished with three pairs of long fine setae. The shield which is situated behind the genital operculum bears a pair of fine

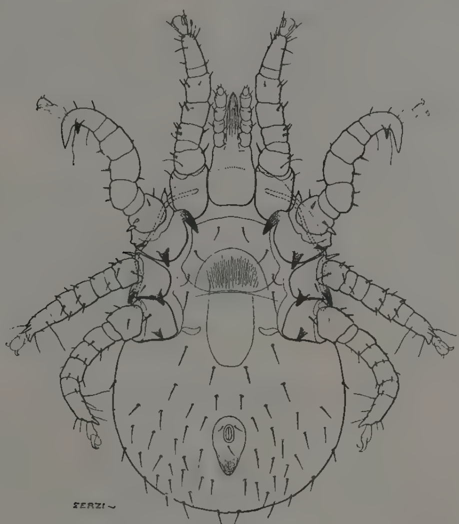

Fig. 2.—*Leiognathus liberiensis*, Hirst, ♀, ventral aspect.

and fairly long setae. Anal plate pear-shaped, its posterior end is finely striated and is blunter than that of *L. creightoni* ; as usual this plate has three setae. *Peritreme* long, the anterior end of it being situated further forward than the greater part of the width of the first coxa. *Legs.* There is a short spine on the dorsal side of the trochanter and a pair of long spines on the femur of the first leg. Second leg stouter than the others ; its coxa is armed anteriorly with a large claw-shaped spur and it has a sharply pointed conical spur and also a little outer spine on the posterior side ; near the dorsal surface of this coxa there is a fairly large anterior spur which points straight forwards ; tarsus of second leg ending in two sharply pointed spurs, the outer one being very large, but the inner one much smaller. Coxa of third leg with two sharply pointed spurs, the outer one being somewhat curved. Fourth coxa with a single spur, which is much

smaller than those of the other legs. Tarsi of third and fourth legs ending in a slight spur, and with an apical spine below. All the legs have pulvilli and the usual paired claws. *Colour* brownish (spirit specimens). *Length* ·7 mm.

Found on a "squirrel" at Rebbo, Bassa, Liberia (*R. H. Bunting*). The specimens were presented to the British Museum (Nat. Hist.) by the Hon. N. C. Rothschild.

Easily recognisable by the peculiar structure of the tarsus of the second leg which ends in two spurs. The shape of the body and of its plates and the armature of the coxae are also important characters.

# REVISED KEYS TO THE KNOWN LARVAE OF AFRICAN CULICINAE.

By F. W. Edwards, B.A., F.E.S.

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When, early in the present year, Dr. A. Ingram sent in to the Entomological Research Committee his collection of larvae and bred adults of Culicinae from Bole, Northern Territories, Gold Coast, the writer decided to describe these as soon as possible, and the opportunity seemed favourable to include a thorough revision of the known larvae of the African Culicinae. The results of this work are given in the following tables. The difficulties of classification might have been considerable, but for the valuable pioneer work of Messrs. Dyar and Knab* in America, and the present author is glad to express his indebtedness to these writers, and would like to add his testimony, if any were needed, to the soundness of their general classification. The paper by Wesché† in this journal is also very important, as it is the only one devoted to a study of the larvae of African Culicidae. Figures of most of the species not illustrated here will be found in it.

All the drawings here given are made from specimens collected by Dr. Ingram at Bole, and with the exception of *C. invidiosus*, which is figured on account of an apparent confusion between that species and *C. univittatus*; and of *S. sugens*, which was very inadequately described by G. Patton, these larvae are here described for the first time. Mr. Engel Terzi's excellent figures make descriptions, apart from those in the keys, superfluous.

*Table of Genera.*

| | | |
|---|---|---|
| 1. | Siphon present ... ... ... ... ... ... ... | 2. |
| | Siphon absent ... ... ... ... ... ... | *Anopheles.* |
| 2. | No ventral brush on anal segment; hairs on head reduced to one pair ... ... ... ... ... ... ... ... | *Eretmopodites.* |
| | Anal brush present ... ... ... ... ... ... ... | 3. |
| 3. | A lateral chitinous plate on the eighth abdominal segment‡ | *Toxorhynchites.* |
| | Eighth abdominal segment with lateral comb ... ... ... | 4. |
| 4. | Siphon usually much elongated, its hair-tufts numerous (rarely absent or represented by single hairs) ... ... | *Culex, Culiciomyia.* |
| | Siphon short or rather short, with only one pair of hair-tufts ... | 5. |
| 5. | Hair-tuft near base of siphon ... ... ... ... ... | 6. |
| | Hair-tuft near middle of siphon (often beyond) ... ... ... | 7. |

* "The Larvae of Culicidae classified as Independent Organisms." By Harrison G. Dyar and Frederick Knab; Journ. N. Y. Ent. Soc., XIV, 1906, pp. 169–230, pls. iv-xvi.

† Bull. Ent. Res. I, April 1910, pp. 6–50, pls. i-vii.

‡ This character also occurs in an undetermined larva of the *Aëdes* group (see note under *Stegomyia sugens*). In this larva, however, the comb is present in addition, which is not the case in *Toxorhynchites*.

6. Antennae short, with a small tuft on the inside ... ... *Theobaldia.*
   Antennae long, with a large plume on the outside ... ... *Ingramia.*
7. Siphon with well-developed pecten ... ... ... ... ... 8.
   Siphon with pecten absent or vestigial ... ... ... ... 9.
8. Head small, longer than broad, and armed with strong spines *Uranotaenia.*
   Head with the ordinary hairs ... ... *Ochlerotatus, Stegomyia.*
9. Siphon normal, valves as usual ... ... ... ... *Mimomyia.*
   A pair of strong, forwardly directed, curved spines at tip of siphon ... ... ... ... ... ... ... ... 10.
10. Valves not enlarged; antennae much enlarged ... ... *Aëdomyia.*
    Valves enlarged into a saw-like structure; antennae long but not much enlarged ... ... ... [*Taeniorhynchus*], *Mansonioides.*

Genus Anopheles, Mg.

1. Shaft of antenna with hair-tuft; no plumose hairs in middle of thorax overlapping occiput ... ... ... *mauritianus*, Grp.
   Shaft of antenna without hair-tuft; plumose hairs present in middle of thorax in front ... ... ... ... ... ... 2.
2. Rudimentary palmate hairs on thorax ... ... ... ... 3.
   Palmate hairs of thorax altogether wanting ... ... ... 6.
3. External anterior frontal hair much branched, forming a pronounced tuft ... ... *squamosus*, Theo., *pharoensis*, Theo.
   External anterior frontal hair simple or slightly branched ... 4.
4. Posterior, and internal anterior frontal hairs simple *funestus*, Giles.
   Posterior, and internal anterior frontal hairs branched ... ... 5.
5. Dark brown; filaments of palmate hairs longer ... *natalensis* (H. & H.).
   Light brown; filaments of palmate hairs shorter ... *ardensis* (Theo.).
6. Median thoracic hairs overlapping occiput rudimentary *maculipennis*, Mg.
   Median thoracic hairs overlapping occiput well developed ... 7.
7. Internal anterior frontal hair branched ... ... ... ... 8.
   Internal anterior frontal hair simple ... ... ... ... 9.
8. Palmate hair of second abdominal segment fully developed, the leaflets with a distinct shoulder; filaments of all palmate hairs about $\frac{1}{3}$ as long as the whole leaflet ... ... ... *costalis*, Lw.
   Leaflets of palmate hair of second abdominal segment without shoulder; filaments of all other palmate hairs under $\frac{1}{4}$ as long as the whole leaflet ... ... ... ... ... *jacobi* (H. & H.).
9. Hair at tip of antennae (between the two spines) split into two *cinereus*, Theo.
   Hair at tip of antennae split into three ... .. ... ... 10.
10. Palmate hair on second abdominal segment well-developed *pretoriensis* (Theo.).
    Palmate hair on second abdominal segment rudimentary *rufipes* (Gough).

The foregoing table is not given with any confidence, for, in the first place, I have been unable, from want of material, to devote much study to the larvae

of *Anopheles*. Secondly, the specific characters of *Anopheles* larvae are less well defined, or at least are more minute, than in those of other CULICIDAE, and hence errors of determination are easily made.

One probable case of such error is the larva described by Newstead and Carter as that of *A. squamosus*, var *arnoldi*, Chr. This larva has an antennal hair-tuft, and in several other points agrees with Hill and Haydon's description of *A. mauritianus* (*paludis*), while it is very different from the form which Hill and Haydon figure as *A. squamosus*. It seems possible, if not probable, that the larvae in question are really those of *A. mauritianus*. I have been unable to separate the supposed larvae of *A. squamosus* and *A. pharoensis*.

## Genus TOXORHYNCHITES, Theo.

*T. brevipalpis*, Theo. As this is the only common African species, and the only one recorded from Sierra Leone, I have no hesitation in assigning to it a larva taken at Moyamba, Sierra Leone, by Dr. J. S. Pearson, in August 1912. This is the only *Toxorhynchites* larva that has been received here from Africa. The larva should be distinguishable by its large size alone, but the following brief description should make its determination easy :

*Head* large, highly chitinised ; median hairs absent. Antennae rather short, cylindrical, without tuft, but with two or three fine single hairs near apex. *Thorax* with the plumose hairs short and thick, median ones rudimentary. *Abdomen* with plumose hairs on every segment, all set, like those of the thorax, in small chitinous sclerites. A large lateral plate on the eighth segment, replacing the comb. *Siphon* not much longer than anal segment, no pecten ; hair-tuft of three plumose hairs situated near the base.

General appearance : dark brown above, light brown below.

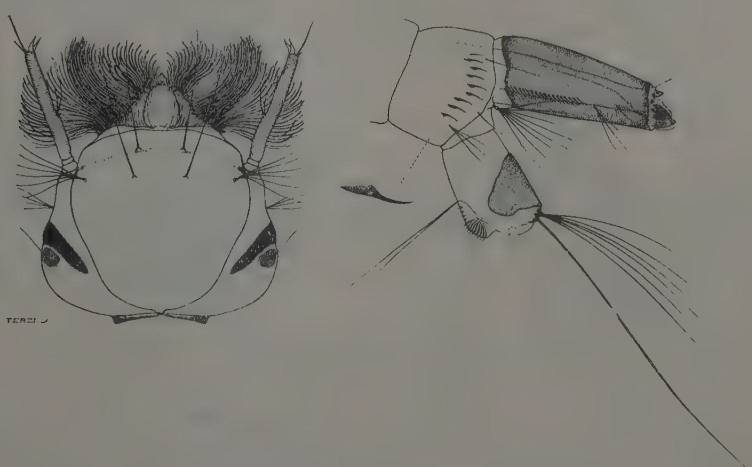

Fig. 1.—*Stegomyia sugens* (Wied.).

The hair beyond the tuft of the pecten is a very unusual feature.

## Genus OCHLEROTATUS, Arrib.
## (including STEGOMYIA, Theo.)

1. Antennae short, without hair-tuft on shaft; anal brush small and not very distinct ... ... ... ... ... ... ... 2.
   Antennae longer, with hair-tuft; anal brush quite distinct ... 3.
2. Siphon more than twice as long as broad, the hair-tuft well beyond the middle; comb scales 8–9, barbed ... *S. fasciata* (F.).
   Siphon less than twice as long as broad, the hair-tuft at about the middle; comb scales 10–12, simple ... *S. africana*, Theo., and *S. apicoargentea*, Theo.
3. Median hairs on head, single... ... ... ... ... ... 4.
   Median hairs on head, triple or multiple ... ... ... ... 5.
4. Pecten without detached teeth outwardly; siphon less than three times as long as broad ... ... ... ... *S. sugens* (Wied).
   Pecten with detached teeth outwardly; siphon more than three times as long as broad ... ... ... ... *O. nigeriensis* (Theo).
5. Median tufts on head each composed of three hairs; pecten with 6–8 teeth wide apart ... ... ... ... ... ... 6.
   Median tufts on head each composed of 6 to 8 hairs; pecten with 12–18 teeth ... ... ... ... ... ... ... ... 7.
6. Siphon curved, four times as long as broad; comb with about 6 teeth; papillae four or five times as long as anal segment *O. punctothoracis* (Theo.).
   Siphon straight, three times as long as broad; comb with 8 teeth; papillae three times as long as anal segment *O. caliginosus* (Grah.).
7. Comb consisting of five large teeth ... ... *O. domesticus* (Theo.).
   Comb consisting of a patch of small scales (20–30 ?) ... ... 8.
8. Hair-tuft normal, branched, situated in middle of siphon *O. marshalli* (Theo.).
   Hair-tuft reduced to a single hair, situated at $\frac{2}{3}$ of siphon *O. nigricephalus* (Theo.).

The larva of *O. longipalpis* Grünb. (*pollinctor*, Grah.) has been insufficiently described, and the specimens in the British Museum are too damaged for purposes of tabulation.

The comb in the last two species is very difficult to see, and I cannot determine the number of scales.

The larva of *S. fasciata* when young has only the apical half of the siphon darkened, and this should greatly help in its determination, as I know of no other similar case.

The genera *Stegomyia* and *Ochlerotatus* do not seem separable from one another or from the genus *Aëdes* when larvae alone are considered. All the known *Stegomyia* larvae, except that of *S. sugens*, agree in having a tuftless antenna; these species in the adult have the larger claws of the male simple, at least on the mid legs. *S. sugens*, however, which has toothed male claws, has typical *Stegomyia*

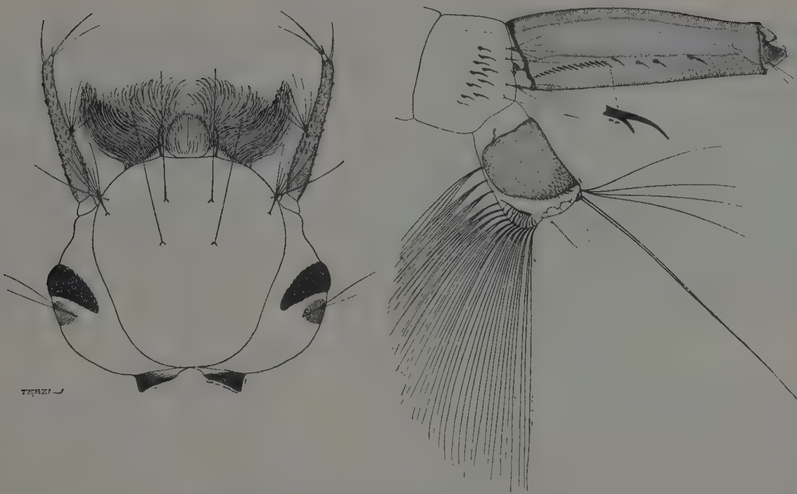

Fig. 2.—*Ochlerotatus nigeriensis* (Theo.).

The hair-tuft on the siphon has been omitted in the figure ; its position is mid-way between the two last teeth of the pecten.

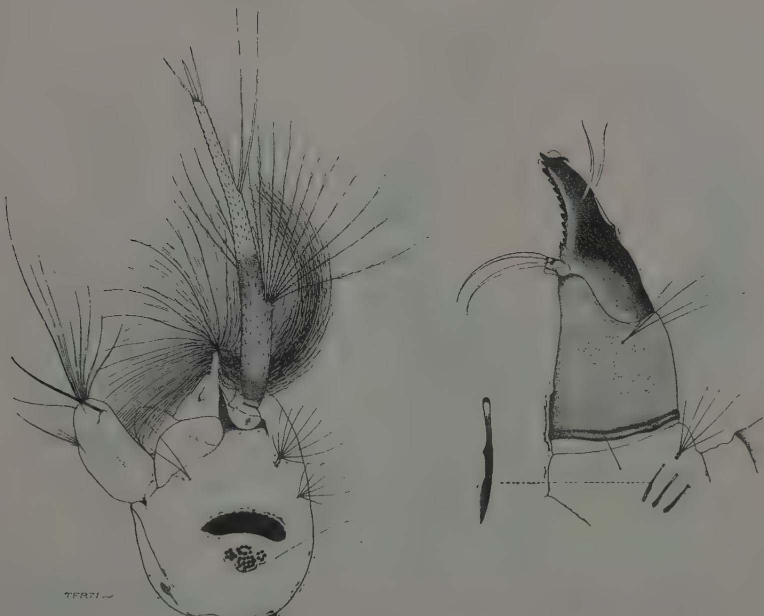

Fig. 3.—*Mansonioides africanus*, (Theo.).

palpi. Patton's figure of the larval head of *S. sugens* certainly does not correspond with the specimens sent by Dr. Ingram. Either Patton's drawing is incorrect, or there are two allied species, or a mistake may have been made by one collector or the other. It should also be mentioned that another very different larva has been received as that of *S. sugens*, possessing a lateral chitinous plate on the eighth segment, the edge of which plate is produced into comb-teeth. These larvae formed the majority of a mixed lot collected in Sierra Leone by Dr. J. Y. Wood, and forwarded for identification by Dr. J. H. Ashworth. The adults bred by Dr. Wood were *S. sugens* and *Uranotaenia nigripes*, but there were no *S. sugens* or *Uranotaenia* larvae amongst those which were preserved.

### Genus Mansonioides, Theo.

*M. africanus* (Theo.).* Fresh figures of this species are given, as those in Dr. Ingram's paper† were not sufficiently detailed. The larva has a rather close resemblance to that of the North American *Taeniorhynchus perturbans*, Walk.; but the larva of no African species of *Taeniorhynchus* has yet been found. The palpi are large, and, as in *Aëdomyia*, they hang downwards. The strong curved spines found at the tip of the siphon tube in both genera may indicate a relationship. One striking peculiarity in this genus (seen also in *Taeniorhynchus*) is the extraordinary development of the valves, which are specialised for attaching the larva to its host-plant.


Fig. 4.—*Aëdomyia catasticta*, Knab.

* An examination of the male genitalia proves that *M. africanus* is after all quite distinct from *M. uniformis*; figures will be given later. Both species occur commonly in Africa.

† Bull. Ent. Res. III, p. 76 (1912).

### Genus Aëdomyia, Theo.

*A. catasticta*, Knab. This larva is most peculiar. The antennae are enormous, and flattened laterally, the subterminal bristles, as in *Mansonioides*, being remarkably long. The palpi are very large, placed unusually far back on the head, and are provided with a large membranous flap and a long terminal spine. In all the specimens they are pendent. The plumose hairs on the front of the thorax are of a most extraordinary length, reaching far beyond even the tips of the antennal bristles. Though the siphon has no definite pecten, it has a transverse row of soft hairs near the base, and another row of similar hairs on the ventral side. Soft hairs are also present on the dorsal side of the anal segment, which, so far as I know, is an absolutely unique character.

There seems to be nothing very distinctive about the pupa. The respiratory tubes are moderately short and the anal flaps are normal in form.

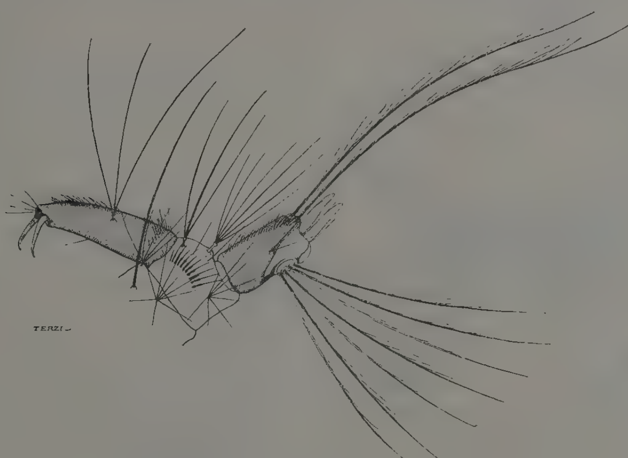


Fig. 5.—*Aëdomyia catasticta*. Knab.

### Genus Theobaldia, N.-L.

Pecten with about 25 teeth, most of which are produced into long hairs ; tuft of antennae moderately small ... *annulata* (Schrank).
Pecten with seven teeth, which though acuminate are not produced into hairs ; antennal tuft minute ... ... ... *spathipalpis* (Rond.).

### Genus Culex, L.

(including Culiciomyia, Theo.)

1. Siphon swollen towards the middle, with a more or less distinct dark ring near the apex ; no distinct hair-tufts, these being represented by long solitary hairs... ... ... ... *duttoni*, Theo.
   Siphon not swollen towards the middle, hair-tufts usually distinct even if small ... ... ... ... ... ... ... 2.

2. Siphon short, not more than three times as long as its basal width: tufts in a ventral row ... ... ... ... ... ... 3.
   Siphon long, at least four times as long as its basal width (usually much longer) ... ... ... ... ... ... ... 4.
3. Mandibles large, dentate; anal segment pointed, longer than siphon; 8–10 pairs of hair-tufts on siphon, all ventral *tigripes*, Grp., var. *fuscus*, Theo.*
   Mandibles normal; anal segment truncate, shorter than siphon; 6–7 pairs of hair-tufts on siphon, 4 or 5 ventral, 2 lateral *Culiciomyia nebulosa* (Theo).

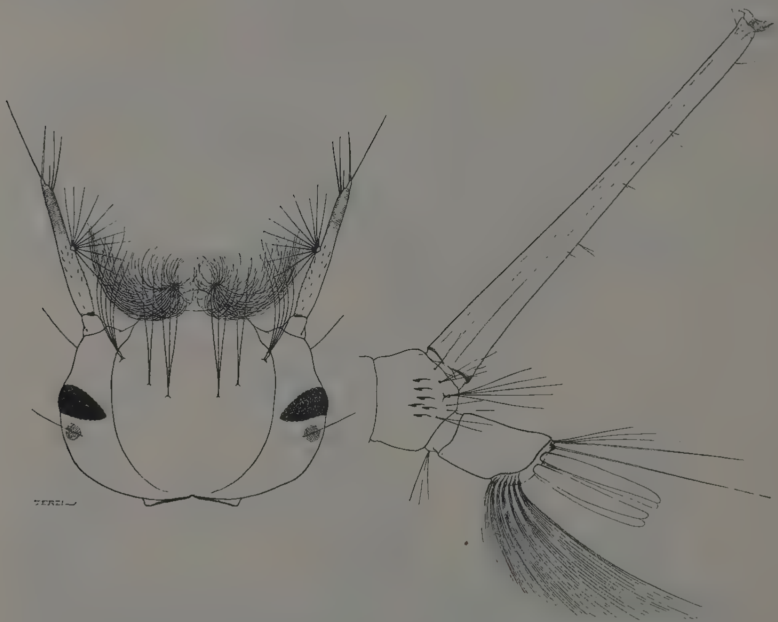

Fig. 6.—*Culex ager* (Giles), var. *ethiopicus*, Edw.

4. Comb of eighth segment with about 40 teeth in a triangular patch ... ... ... ... ... ... ... ... 5.
   Comb of eighth segment with less than 20 teeth; antennal plume at $\frac{3}{5}$ or before ... ... ... ... ... ... ...

* This species would fall into the genus *Lutzia* (=*Jamesia*) as used by Dyar and Knab, but as there is no tangible adult character to separate it from *Culex* I prefer not to use it. The larval characters distinguishing it from typical *Culex* are the predaceous habit, the outwardly folded mouth-brush modified into a prehensile pencil, and the pointed anal segment.

5. Siphon 4 × 1; pecten with about 9 teeth; antennal tuft at about $\frac{3}{5}$ ... ... ... ... ... *quinquefasciatus*, Say.*
   Siphon longer; pecten with 12–15 teeth; antennal tuft at about $\frac{3}{4}$ 6.
6. Siphon 5 × 1 ... ... ... ... ... ... ... *pipiens*, L.
   Siphon 8 × 1 ... ... ... ... *decens*, Theo.; *invidiosus*, Theo.
7. Comb with 15–18 teeth, in two or three irregular rows ... ... 8.
   Comb with 4–8 teeth, in one row ... ... ... ... ... 9.
8. Siphon longer than the abdomen, 20 × 1 ... ... *guiarti*, Blanch.†
   Siphon about the same length as the abdomen, 13 × 1 ...*grahami*, Theo.
9. Siphon as long as abdomen; pecten with about 13 teeth, the last six far apart and reaching more than two-thirds of the length of the siphon ... ... ... ... ... ... ... *pruina*, Theo.
   Siphon not more than half as long as abdomen, pecten with at most 10 teeth, which reach at most one-third the length of the siphon ... ... ... ... ... ... ... ... 10.
10. Siphon with a more or less evident dark ring at one-third, the hair-tufts very long; head very dark ... ... *quasigelidus*, Theo.
    Siphon unicolorous, the hair-tufts short and inconspicuous; head not very dark ... ... ... ... ... ... ... 11.
11. Siphon less than half as long as abdomen; antennal tuft just before middle; pecten with five teeth, very short and close together ... ... ... ... ... ... *annulioris*, Theo.
    Siphon about half as long as abdomen ... ... ... ... 12.
12. Pecten with only three teeth; antennal tuft just beyond middle *ager* (Giles), var. *ethiopicus*, Edw.
    Pecten with six teeth, the last two more detached *univittatus*, Theo.

There is unfortunately some confusion between the larvae of *C. invidiosus* and *C. univittatus*. The former have been received from Lagos (*Dr. W. M. Graham*) and Accra (*Dr. A. C. Connal*), while larvae identical with these, received from Bole (*Dr. A. Ingram*), were labelled as those of *C. univittatus*. Dr. Ingram also sent a perfectly distinct larva which was labelled as that of *C. invidiosus*. I have assumed that the labels have been accidentally transposed in the case of Dr. Ingram's specimens, and have taken the species labelled *C. invidiosus* to be *C. univittatus*.

I am unable to separate the larvae of *C. decens* (= *C. nigrocostalis*, Theo. and *C. lividocostalis*, Graham) and *C. invidiosus* (= *C. aquilus*, Graham), the characters given by Wesché being unreliable, but I believe the two are distinct. In the adult, *C. decens* can be distinguished by the reddish thorax (that of *C. invidiosus* being brownish), and (in the male) the banded abdomen. In the female the abdominal banding is not constant; the bands in *C. decens* are always narrow and may sometimes be interrupted. However, a close microscopical examination of the genitalia of a number of males of each species failed to

* Characters given by Dyar and Knab. This is the species often referred to as *fatigans*, Wied.

† This determination is questionable. No specimens of *C. guiarti* from Lagos are in the British Museum Collection.

reveal any differences. It is therefore quite possible that the two are really only forms of one species; they generally occur together, but specimens bred from one batch of larvae exhibit little variation.

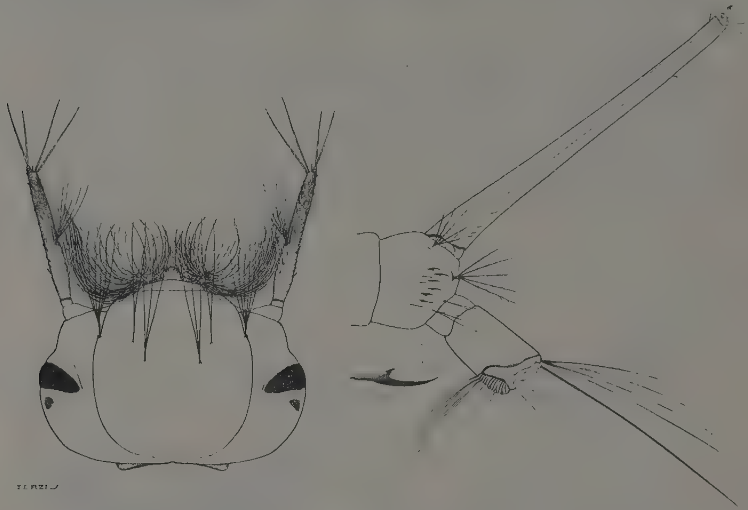

Fig. 7.—*Culex annulioris*, Theo.

Two ventral siphonal hair-tufts have been omitted in the figure: one about in the middle, the other between it and the one shown; there is also a lateral pair near the apex. Two out of the three specimens had only four comb teeth.

Fig. 8.—*Culex invidiosus*, Theo.

The specimen drawn was abnormal in having the chitinous ring of the anal segment incomplete. The siphon was damaged; perfect specimens received from Lagos (*Dr. A. C. Connal*) show six pairs of hair-tufts. The hairs on the head and the antennal tuft are plumose.

The slight differences noted by Wesché between different lots of *C. duttoni* larvae (distinguished by him under the names *dissimilis*, Theo. and *albovirgatus*, Graham) are evidently not of specific value; the length of the siphon varies with the age of the larvae,* and also individually. Nor can much importance be attached to the anal papillae, which also vary somewhat. In the batch of larvae described by Wesché as *C. dissimilis*, there is only one which has kept its papillae, and in this the shorter pair are rather shrivelled, on account of which Wesché stated that the dorsal papillae were about double the length of the ventral. Normally in *C. duttoni* they are not much longer.

Apparently there may be a good deal of difference between larvae of different ages. Two larvae of *C. quasigelidus*, sent by Dr. Ingram, illustrate this well. Though seemingly of the same species (both having the well-marked dark ring on the siphon) they differ as follows: the larger has eight or nine teeth in the pecten, and three ventral pairs of plumose hair-tufts on the siphon, the chitinous ring on the anal segment is complete, and the head is very dark; the smaller has only six finer teeth in the pecten, four ventral tufts of simple hairs on the siphon, a chitinous saddle on the anal segment, and a light brown head.

*Culiciomyia* is also variable. Normally *C. nebulosa* has four ventral pairs of hairs-tufts on the siphon, but occasional specimens have five. The number of teeth in the pecten varies from two to five, and may not be the same on opposite sides of the siphon. Larvae from the same batch vary in the length and amount of plumosity of the antennal tuft. In the pupae, too, the notch in the anal flap is much more distinct in some specimens than in others, and may be almost indistinguishable. When the impossibility of separating the adults is also taken into consideration, there can be little doubt that the larvae and pupae described by Wesché as *Culiciomyia freetownensis* and *C. cinerea* are really varieties *C. nebulosa*. It should be mentioned that neither of the larvae described by Wesché for *Pectinopalpus fuscus* can possibly belong to this species.

## Genus Mimomyia, Theo.

Large species; comb consisting of seven moderate-sized teeth, rather irregularly placed; posterior edge of anal segment slightly spinose ... ... ... ... ... *plumosa* (Theo.).
Small species; comb consisting of six or seven large teeth placed almost in a straight line; posterior edge of anal segment markedly spinose ... ... ... ... *mimomyiaformis* (Newst.).

It is unfortunate that Dr. Ingram did not send home any larvae of this genus, except one of *M. plumosa*. He did, however, send pupae, and these can be distinguished by the following table. All have respiratory tubes of great length; this character also occurs in *Mansonioides* and *Taeniorhynchus*.

1. Anal flaps narrow, with a broad fringe of cilia, transparent, except at the tip, where they are darkened ... *splendens*, Theo.
Anal flaps broader, not fringed, dark, with white spots ... ... 2.

* I have found this to be the case in breeding *Culex pipiens*, and still more strikingly in *Theobaldia annulata*. The younger larvae have the shorter siphons.

2. Anal flaps with two equal-sized white spots ... *plumosa* (Theo.).
   Anal flaps with only one white spot... ... ... ... .. 3.
3. Respiratory tubes with the tip only white ... *mimomyiaformis* (Newst.).
   Respiratory tubes with the apical third white, except for the dark tip ... ... ... ... ... ... *hispida* (Theo.).

## Genus URANOTAENIA, Arrib.

The only African species of this genus whose larva is definitely known is *U. balfouri*, Theo., and this is typical in every respect.

*U. nigripes*, however, has had attributed to it a peculiar Sabethine larva (*vide* Theobald, Trans. Linn. Soc. xv, 1912, p. 93, under *Pseudoficalbia nepenthes*) which has some resemblance to that of *Eretmopodites*. So far as I can see from

Fig. 9.—*Ingramia malfeyti* (Newst.).

some badly made balsam preparations in the British Museum, this larva has no pecten and no hair-tuft on the siphon, no comb, and no cephalic hairs. It can have no possible connection with *Uranotaenia*, nor can it very well be *Eretmopodites*, if the comb is really absent.

## Genus INGRAMIA, Edw.

*I. malfeyti* (Newst.). This is the only species of the genus whose larva is known. The most marked character is the form of the antennae. As, however, these organs

are only present in one specimen, and seem to be somewhat distorted, the external position of the tuft may not be normal. The basally situated siphon tuft is unusual.

### Genus Eretmopodites, Theo.

Siphon almost three times as long as broad, pecten present, containing three spines, two short and one long, tuft absent; comb-teeth sharply pointed ... ... ... ... *chrysogaster*, Grah.

Siphon hardly twice as long as broad, pecten absent, the only appendage of the siphon being the two-haired tuft; comb-teeth blunt-ended, and rather nearer together than in the preceding *inornatus*, Newst.

The pupae of these two species are easily distinguishable, for while in *E. chrysogaster* the anal flaps have only one terminal bristle, in *E. inornatus* they have several (from three to seven) in a tuft.

Young larvae of *E. chrysogaster* are very much like the full-grown ones, but have fewer comb-scales (about 12 instead of about 30).

# ON THE CHANGES WHICH OCCUR IN CERTAIN CHARACTERS OF ANOPHELES LARVAE IN THE COURSE OF THEIR GROWTH.

By A. T. Stanton,

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## Introductory.

It is generally admitted that the ability to determine the species of *Anopheles* by an examination of their larvae would place a valuable weapon in the hands of the practical sanitarian in tropical countries. In the investigation of an area for the determination of the *Anopheles* present, it frequently happens that, on account of their habit of concealment by day, adult mosquitos are difficult to find, whereas their breeding places may be located readily. If the larvae are transported to a distance they commonly do not develop further, and so, failing the specific identification of the larvae themselves, valuable information is lost. It is therefore very desirable to know whether, and to what extent, any of the characteristics of such larvae may safely be employed in determining their species.

Grassi[1] was the first to direct attention to certain characters of *Anopheles* larvae, notably the form of the clypeal hairs, which he considered to be of value in their specific differentiation. The valuable observations of James[2] and Christophers[3] added greatly to the knowledge of the subject, but later studies in India and elsewhere appeared to show that these characters were not constant in the same species. James and Liston[4], in the second edition of their monograph on "The Anopheline Mosquitoes of India," give expression to the prevalent belief that "in the larvae of common species some of the characters vary considerably and therefore for purposes of identification we are not now inclined to attach very great importance to them."

In the course of a study of the *Anopheles* mosquitos of the Malay Peninsula, it was possible by breeding out larvae from the eggs of known species to follow the changes in them at successive ecdyses up to maturity. The results of these observations are set forth in the present paper, and it is believed that they account for the anomalous results obtained by previous workers in this field of research, by showing that the supposed variations of any specific larva are really changes of a constant kind associated with successive phases of development. The difficulty of breeding out larvae from the eggs laid by mosquitos in captivity was not found to be insuperable, and it is considered that the study of such larvae offers certain advantages over the study of the skins cast on their transformation to pupae or of groups of larvae from which a single species subsequently hatches out.

The larvae of the following species were studied :—*A. albirostris*, *A. sinensis*, *A. fuliginosus*, *A. nigrans* (= *A. karwari*), *A. umbrosus*, *A. rossi*, and *A. ludlowi*. As the results were constant and parallel in the case of each species, it will suffice for the present purpose to give an account of only one of these, and I have selected *Anopheles albirostris*, Theobald, one of the malaria-carrying species of the Malay Peninsula.

The form and arrangement of the anterior clypeal hairs and of the posterior clypeal hairs situated on the front of the head (fig. 1 A), and of the palmate hairs situated on the thorax in certain species and on a varying number of the abdominal segments (fig. 1B), are the characters in which the most striking changes occur, and these will now be described in detail.

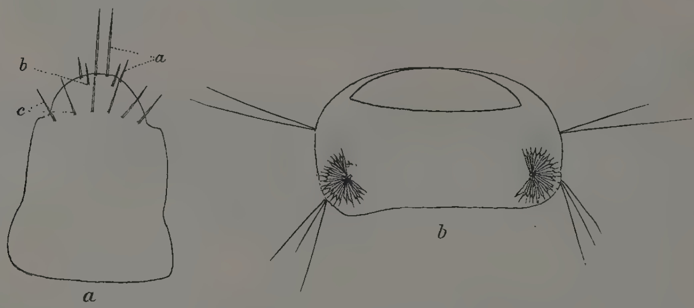


Fig. 1.—A.—Head of larva of an *Anopheles*, dorsal view, showing (*a*) anterior and (*b*) posterior clypeal hairs, and (*c*) frontal hairs. B.—Abdominal segment of full-grown larva of *Anopheles albirostris*, dorsal view, showing "palmate hairs" fully developed.

## Growth-changes observed in the larva of Anopheles albirostris.

When newly hatched from the egg, the tiny larva of *Anopheles albirostris* is characterised as follows :—The anterior clypeal hairs, the inner being long and the outer short, are simple bristles ; the posterior clypeal hair is also simple and is situated behind and slightly internal to the outer anterior clypeal (fig. 2) ; the

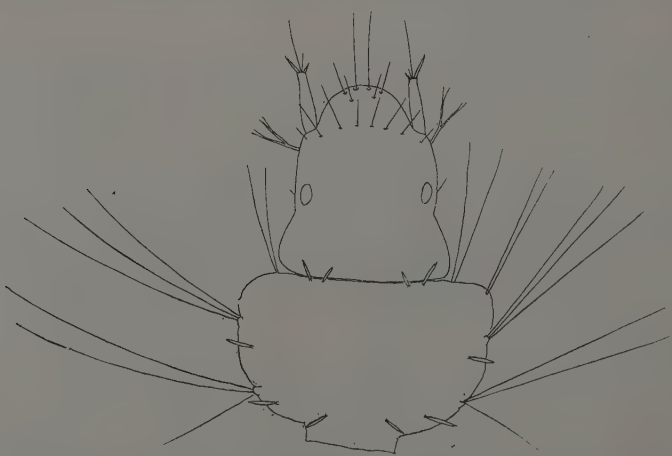

Fig. 2.—Head and thorax of newly hatched larva of *Anopheles albirostris*, showing the hairs all simple.

dorsal structures, some of which in full-grown larvae become what are known as "palmate hairs," are represented by simple lanceolate leaflets (fig. 3*a*); these are situated five on each side of the thorax and one on each side of the abdominal segments from the second to the seventh, and are longer on the posterior segments than on those nearer the thorax.

The *Anopheles* larva at this stage approximates in several of its characters to mature *Culex* larvae and appears to indicate the mode of origin of *Anopheles* as a differentiation from pre-existing *Culex* forms. The lateral thoracic and abdominal hairs are simple, as in most mature forms of *Culex* larvae. The papilla, at the base of which the tracheae open, is more prominent than at later stages and is semi-tubular (fig. 3*b*), recalling the form of the breathing tube of *Culex*. It

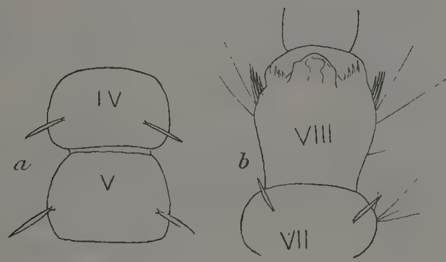


Fig. 3.—Newly hatched larva of *Anopheles albirostris*; *a*, 4th and 5th abdominal segments, showing simple lanceolate leaflets; *b*, 8th abdominal segment, showing prominent semi-tubular papilla.

should be noted that when they leave the egg all species of *Anopheles* larvae are very much alike at a casual inspection and that in several particulars they bear a close resemblance to *Culex* larvae.

After three or four days growth the characters of the larva of *A. albirostris* begin to approximate those of the mature form and are as follows (fig. 4):—The

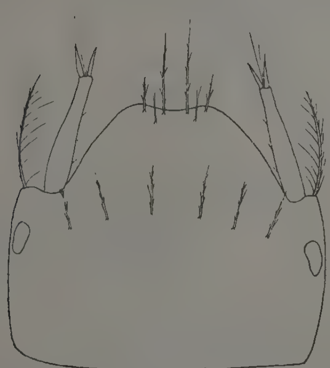

Fig. 4.—Head of larva of *Anopheles albirostris* after first moult, showing that the simple clypeal and frontal hairs have become subplumose.

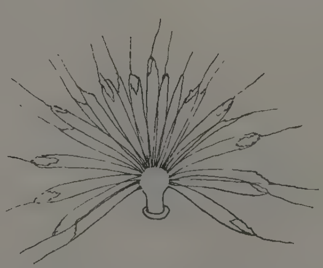

Fig. 5.—Cockade, or "palmate hair," from the 5th abdominal segment of full-grown larva of *Anopheles albirostris*, showing the great change from the condition illustrated in fig. 3*a*. Greatly magnified.

anterior clypeal hairs now show traces of feathering; the posterior clypeal hair is forked and is placed nearer the mid line; instead of a single leaflet, the palmate hair now becomes a whorl of lanceolate leaflets. Four of the five simple leaflets on each side of the thorax in the first stage are transformed, not into rosette-like palmate hairs, but into stout feathered hairs, and one of the simple bristles on the lateral aspect of the first abdominal segment is transformed into a whorl of leaflets.

A curious feature of the larva of *Anopheles umbrosus* in regard to the palmate hairs should here be noted. Neither in the newly hatched larva of this species nor in its more mature form have any leaf-like palmate hairs been observed, their place being taken by simple bristles and feathered hairs. The larva nevertheless assumes in the water the horizontal position common to all *Anopheles* larvae.

With the further growth of the larva and at successive ecdyses, the branching of the clypeal hairs becomes more marked, and the form of the palmate hairs alters until the characteristic form and arrangement of these hairs in the mature larva are attained (fig. 5).

At maturity (fig. 6), the anterior clypeal hairs are much feathered; the posterior clypeal hair, now situated behind and near the inner exterior clypeal, consists of a very short stem from which four or six branches arise; on the thorax and first abdominal segment, the leaflets of the palmate hairs are lanceolate, and on the second to seventh abdominal segments they are jagged at the base of the terminal filament, which is long and sharply pointed (fig. 5).

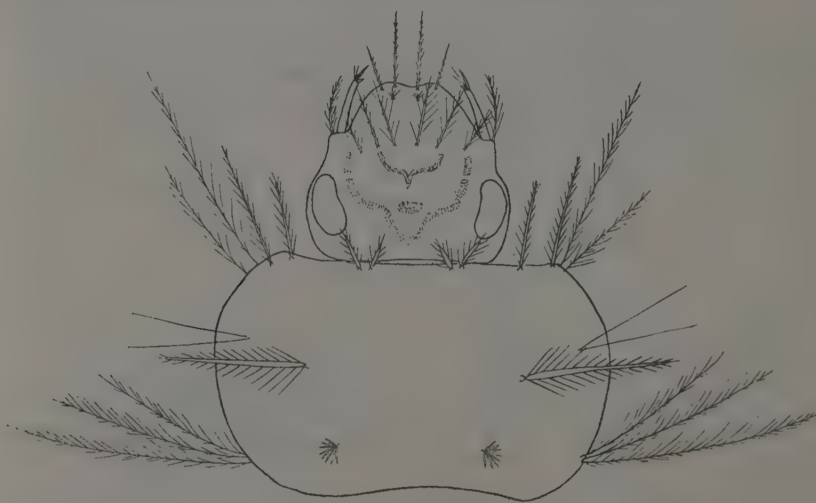

Fig. 6.—Head and thorax of full-grown larva of *Anopheles albirostris*, showing that all the hairs, etc., have become either plumose or subplumose.

Save in the case of a few closely-related species, of which *rossi* and *ludlowi*, *sinensis* and *barbirostris* are examples, the mature forms of larvae of Malayan *Anopheles* have been found to possess characteristic features which permit of

their specific differentiation. So far, only the anterior and posterior clypeal and the palmate hairs have been studied in detail, and it is hoped that further study will reveal points of difference which will enable one to recognise the mature forms of *all* valid species. It may well be that the distinctive characters which may be observed in these developmental stages will form the basis for a more satisfactory grouping of adult *Anopheles* than that which has been founded upon scale characters alone.

The drawings accompanying this paper were executed by Col. A. Alcock, C.I.E., F.R.S., to whom I am under obligation for this and other valued advice and assistance in the preparation of these notes.

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# ANOPLURA FROM AFRICAN HOSTS.

By Bruce F. Cummings.

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The following notes and descriptions are based on material received by the Entomological Research Committee, who have kindly presented the types of the new species to the National Collection.

## Genus Scipio, nov.

Type: *Haematopinus aulacodi*, Neumann (Archives de Parasitologie, 1911, p. 403).

Head long and broad, the 3rd joint of the antenna very long, almost equal to the length of the 2nd, 4th and 5th together. Thorax shorter and broader than the head. First pair of legs with a long slender claw and, arising close beside it, another claw, half the length of the first, hook-shaped and enlarged at its base. The pretarsal sclerite of the 2nd and 3rd pairs of legs very large. Abdomen ovoid, as long as head and thorax together; pleurae small but strong, the posterior ones drawn out into tubular processes as in *Solenopotes*.

The foregoing diagnosis is based on two specimens of *S. aulacodi*, ♂ and ♀, off *Thryonomys swinderianus*, Temminck, from Chirimanyama stream, Luangwa Valley, North-Eastern Rhodesia (*S. A. Neave* 11. ix. 1910). The ♂ is much smaller than the ♀, with the terminal segment of the abdomen rounded.

## Genus Neohaematopinus, Mjöberg.

Arkiv. för Zoologi, VI, 1910, p. 160.

This is Mjöberg's genus for *Haematopinus sciuropteri*, Osborn (Bull. 5, U.S. Dept. Agric. 1896, p. 182). Immediately succeeding his diagnosis of this genus Mjöberg proposes another new genus, *Acanthopinus*, for a species, *A. sciurinus* (from *Sciurus vulpinus*), in which the basal joint of the antennae in both ♂ and ♀ is very thick and runs out at the distal postaxial corner into a strong spinous projection. But unlike *Neohaematopinus*, the 3rd joint in the ♂ of *Acanthopinus* does not run out preaxially into a strong prominence. Some Anoplura from *Heliosciurus palliatus*, Peters, (British East Africa) are closely allied to both these species and in the form of the antennae combine the characters of the 1st joint in *Acanthopinus* with those of the 3rd joint of *Neohaematopinus*. Mjöberg's second genus ought therefore to be sunk and the new species is described below under *Neohaematopinus*. Neumann's species, *Haematopinus echinatus* (Arch. Parasit., April, 1910, p. 518) should also be included in this genus.

**Neohaematopinus heliosciuri**, sp. nov. (fig. 1).

*Head* a little longer than broad, the anterior border broad, very slightly convex, projecting but little in front of the antennae. Lateral margins expanding a little at

first, broadening, not at right angles yet somewhat abruptly, immediately behind the antennae to form the temples, which posteriorly make a right angle with the lateral borders just before the latter curve in to form the occiput. The occipital border a little convex. A group of bristles on each side at the lower corner of the temple, one very long, with two short ones beside it and a longer one below; near the median line, behind the antennae, two small hairs; another one, a little further forward on each side, near the lower inside corner of the first joint of the antenna; further forward again, but not in front of the antennae, two more small hairs, somewhat nearer the median line than the preceding; a small hair on each side, at the extreme margin of the head, just in front of the antenna; six minute

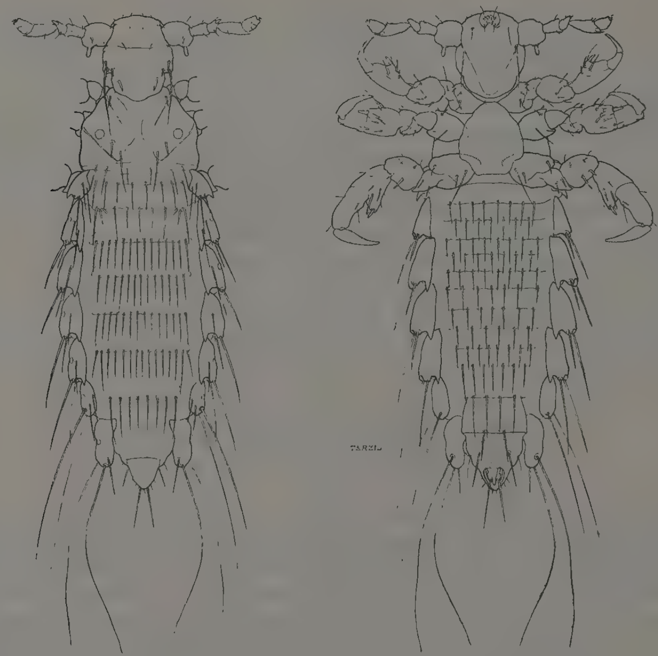

Fig. 1.—*Neohaematopinus heliosciuri*, Cummings, ♂, dorsal and ventral aspects.

hairs on the anterior border of the head. Under surface triangular, with the apex pointing towards the thorax. A bristle on the lateral margin near the antennae; further forward, two smaller hairs inside the margin; another one just in front of the antenna on each side; several small hairs around the area of the rostrum. *Antennae* with the 1st joint very large, an appendix at the distal postaxial corner, with a circular constriction at its base; 2nd joint cylindrical, as long as the first, but only half its width; 3rd joint in the ♂ small, with its preaxial margin twice as long as the postaxial, a short stout spine on the prominence preaxially; the 4th joint pedunculate, a little longer than the second,

with a sense organ at the distal lower corner; apical joint shorter, with its sense-organ half-way along the lower side. In the ♀, the 3rd joint approximating in length to the penultimate, which is scarcely pedunculate. *Thorax* narrow in front, broadening towards the abdomen, posterior margin slightly concave, metathorax short. A spine on each "shoulder" and two in line obliquely with the spiracle. Sternal plate broad and long, the base truncate in the middle, concavely oblique at each side of the base, rounded in front. *Legs:* first pair small, coxae approximated, claw narrow and slender; posterior pairs longer, stouter, with larger claws. *Abdomen* long, parallel-sided in the ♂, longer in the ♀ and narrowing after the middle. Terminal segment of ♂ conical, of ♀ truncate. On the upper surface of the ♂ segment I is small, with six hairs, two on each side and two in the middle; II with two rows of hairs, 8 in the first row and 11 in the second, the three outside hairs in the latter close together and mounted on a slight projection; succeeding segments with one row each of closely spaced hairs; VIII bare, telson conical, with a fairly long hair on the margin at the base on each side, followed by a series of small hairs around the border. In the ♀, on the upper surface, segment II without the lateral projections; succeeding segments with three rows of widely and equally spaced broad hairs; penultimate segment with two rows; terminal segment with one semicircular row. On the under surface of the ♂, segment I bare, II with two rows of hairs, III with three, succeeding segments with two rows of widely spaced hairs, VII with one row of four stout hairs, VIII with only two long hairs, telson with four hairs, two subterminal and two further forward. On the under surface of the ♀, segment II with one row, the succeeding segments with three rows of hairs, VII with two rows and VIII with only one row. Gonopods each with three stout hairs on the outside; anterior lip of the vulva with a serrate edge. Pleurae broad rectangular, except the 8th in the ♂, which is oval and projects almost as far as the end of the abdomen. Each pleura with two bristles at the lower margin; on the 7th and 8th of the ♂ these are abnormally long. Terminal pleurae of ♀ each with a spine and a group of thick bristles.

*Length* (in mm.), ♂ ·975, ♀ 1·70; head, ♂ ·225, ♀ ·2; thorax, ♂ ·175, ♀ ·15; abdomen, ♂ ·575, ♀ 1·35; greatest width, ♂ ·35, ♀ ·4.

HOST: *Heliosciurus palliatus*, Peters.

BRITISH EAST AFRICA: Uchweni Forest, Witu (*S. A. Neave*).

## Genus POLYPLAX, Enderlein.

**Polyplax otomydis**, sp. nov. (fig. 2).

In the presence of a transverse suture behind the head and in the large claws of the hind pairs of legs, this species stands close to *P. suturalis* (Osborn) (Bull. 5, N.S., U.S. Dept. Agric., 1896, p. 185). It is distinguished by its larger size, the long-oval shape of the abdomen and by many other minor features.

♀. *Head* oval, rounded in front, broadening somewhat behind the antennae, the occipital area entering a V-shaped groove in the thorax. A transverse row of four hairs on the upper surface in front of the antennae and immediately in

front of these another widely-spaced transverse row of 4 hairs, the outer ones being on the margin. The transverse furrow or "suture" behind the antennae is concave on the anterior side and accompanied by a row of six small hairs. Two or three minute hairs at the margin of the temples, and a long bristle at each posterior corner, with a comparatively short one beside it. Two short hairs further in near the median line in the occipital area. On the under surface, a raised median area shaped like a wine-glass; close to the basal joint of the antenna on each side a moderately long bristle; in front of the antennae four shorter bristles, and around the mouth of the rostrum four minute hairs. *Antennae* short, thick, 1st joint very broad, squat; 2nd longest, narrower; 3rd

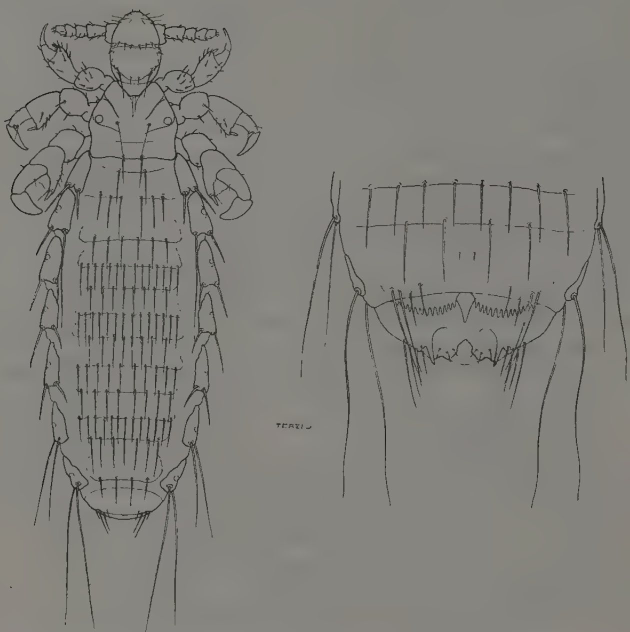

Fig. 2.—*Polyplax otomydis*, Cummings, ♀, dorsal aspect, and ventral aspect of anal segments.

a little longer than the 4th: 5th short, with a sense-organ. *Thorax* short, with convex lateral margins, and receiving the head in a V-shaped groove. A long hair on the mesonotum on each side a little distance in from the lateral margin. Sternal plate pointed behind, rectangular in front. *Legs:* the 1st pair small, claw slender; 2nd pair small, claw broader; 3rd pair large, with stout claw like a parrot's beak; 1st pair of coxae closely approximated, 3rd pair contiguous. *Abdomen* elongate, broadest before the middle, rounded behind. On the dorsal surface, segment I short and small with only two hairs, segment II with a row of six hairs, segment III with one sclerite and one row of hairs; succeeding segments with two sclerites and two rows, but III with one sclerite and one row

of four widely-spaced hairs, the terminal tergite bare. On the ventral surface, I indistinct, bare ; II with two sclerites and two rows of hairs, eight hairs in the 1st row and only two in the 2nd ; III with three sclerites and three rows of hairs ; succeeding segments with two sclerites and two rows, the 2nd row of VII with only four hairs. Anterior lip of vulva with a bilobed serrate edge. The terminal segments on either lateral area with a sharp chitinous projection ventrally and a group of bristles. Pleurae quadrangular, with two spines, one dorsal and one ventral ; the dorsal spine or bristle on the pleura of the segment III very long, extending down the length of the next two segments.

*Length* (in mm.), ♀ 1·125, head ·25, thorax ·075, abdomen ·8 ; greatest width ·35.

HOST : *Otomys irroratus tropicalis*, Thos.

BRITISH EAST AFRICA : Northern slopes of Mt. Kenya, 7,200 ft. (*S. A. Neave*).

Described from several females.

# NEW AFRICAN TABANIDAE.—PART III.

By Ernest E. Austen.

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The types of the eight new species described in the present instalment are in the British Museum (Natural History). The following list shows at a glance the countries in which these additions to our knowledge of the blood-sucking flies of Africa have been obtained.

## *PANGONIINAE.*

Genus Diatomineura (Subgenus Corizoneura), Rond.

| | |
|---|---|
| *Diatomineura lineatithorax*, sp. n. ... | Northern Rhodesia. |
| „ *penetrabilis*, sp. n. ... | „ „ |
| „ *hastata*, sp. n. ... ... | Portuguese East Africa. |

## *TABANINAE.*

Genus Haematopota, Mg.

| | |
|---|---|
| *Haematopota grahami*, sp. n. ... ... | Ashanti ; Sierra Leone Protectorate. |
| „ *daveyi*, sp. n. ... ... | Nyasaland Protectorate. |
| „ *rubens*, sp. n. ... ... | Nyasaland Protectorate ; Northern Rhodesia ; Southern Rhodesia. |
| „ *beringeri*, sp. n. ... ... | Gold Coast (Northern Territories) ; Northern Nigeria. |
| „ *crudelis*, sp. n. ... ... | German East Africa. |

## *PANGONIINAE.*

Genus Diatomineura (Subgenus Corizoneura), Rond.

### **Diatomineura lineatithorax**, sp. n.

♀.—Length (1 specimen) 16 mm. ; width of head 4·75 mm. ; width of front at vertex 1 mm. ; distance from upper margin of occiput to anterior extremity of face 4·2 mm. ; length of proboscis 11·5 mm. ; length of wing 16·25 mm.

*Front mouse-grey* pollinose, anteriorly with a shining dark brown, hastate mark in middle line between and above bases of antennae, and with a patch of black hair immediately above each antenniyerous eminence ; dorsum of thorax resembling that of* Pangonia rostrata, *L., blackish slate-coloured, greyish (brownish-grey or olivaceous-grey) pollinose, with light grey markings ; tergites of first three (visible) abdominal segments shining ochraceous, with an interrupted and not sharply defined, dark, median longitudinal stripe, second and third tergites also with an irregular clove-brown spot or blotch at each lateral extremity ; tergites of fourth and following abdominal segments clove-brown or greyish clove-brown, their lateral borders and also posterior half of fourth tergite, except median third, ochraceous.*

* For names and illustrations of colours, *see* Ridgway, 'A Nomenclature of Colors for Naturalists' (Boston : Little, Brown & Company, 1886).

*Head*: front above supra-antennal patches of black hair clothed with yellowish hair; upper surface of face smoke-grey pollinose; sides of face, except orbits which are yellowish-grey pollinose, greyish dark brown, without shining calli, a patch of black hair mixed with yellowish hairs below each antenna, close to groove at base of facial prolongation; jowls, basi-occipital region, and occiput whitish-grey pollinose, jowls and basi-occipital region thickly clothed with whitish hair; *palpi* dark brown (terminal joint reddish-brown), under side of proximal joint, except distal third, with long whitish hairs, which are more numerous at base; first and second joints of *antennae* greyish clove-brown, clothed above with blackish hairs, third joint dark chestnut or dark reddish-brown, distal extremity dark brown. *Thorax*: dorsum with a pair of narrow, light grey, longitudinal stripes, commencing on front margin, where they broaden out slightly, and enclosing rather more than median third; a little beyond the transverse suture the narrow grey stripes become indistinct, but each sends out an offshoot along the portion of the transverse suture with which it is in contact, and this offshoot bifurcates at its outer extremity, passing forwards and backwards along outer border of dorsum; portions of dorsum immediately behind and in front of transverse suture on each side, and enclosed between narrow grey longitudinal stripe and its offshoot just described, clove-brown, darker than remainder of dorsum; inner margins of narrow grey longitudinal stripes bordered with olive-brown, and a broader but less sharply defined longitudinal stripe of same colour in centre of dorsum; hairy covering of dorsum yellowish and silky, sparsely mixed with blackish hairs on main portion of dorsum, a small patch of black hair behind each humeral callus; above base of each wing is a fringe of closely-set whitish hair; outer surface of each postalar callus fringed with similar but longer hair, upper surface of postalar calli clothed with black hair; pleurae and pectus grey pollinose, densely clothed with whitish hair, which is visible in front of wings when insect is viewed from above. *Abdomen*: tergite of first segment with a slate-grey median blotch, as wide as scutellum at base but narrowing towards hind margin, which it only reaches in centre, its posterior angles being rounded off; tergite of second segment with a rounded, clove-brown, median spot at base, in contact with front margin; distally the spot is prolonged towards the hind margin of the second tergite by an irregularly mottled, wider, dusky patch (but the posterior fourth of the segment is entirely free from dark markings of any kind), the dark median blotch formed by the basal spot and its prolongation looking like an ill-defined truncate triangle, with forwardly directed apex; tergite of third segment with an ill-defined dark median blotch similar to that on second segment, but extending from front to hind margin, and with a less distinct clove-brown spot or nucleus at base; on second, third, and fourth tergites the median dark blotch in each case is overlaid by an ill-defined grey pollinose triangle (most distinct when insect is viewed at a low angle from behind), with forwardly-directed apex; fifth and following tergites entirely greyish pollinose, except in case of fifth tergite, on which a transversely elongate streak of ground colour is exposed on each side, next base; lateral clove-brown spots larger and more transversely elongate on third than on second tergite, nearer front than hind margins, but not actually in contact with front margin in either case; tergite of first segment with its posterior angles clothed with outstanding ochreous hair, and

on hind margin with a small median patch of appressed pale yellowish hair; posterior angles and lateral margins (except anterior halves of lateral margins in case of second and third segments) of tergites of following segments clothed with silvery-white hair, which is longest on posterior angles of fifth tergite; second and third tergites each with a median patch of appressed, glistening whitish hair on or adjacent to hind margin, and on hind border on each side of this patch, and between it and posterior angle, clothed with appressed, glistening, ochreous or pale yellowish hair; hind borders of fourth and fifth tergites, except rather less than median third in case of latter, clothed with appressed glistening whitish hair, which on fourth tergite in middle line also extends forwards as a roughly triangular patch almost reaching front margin; dorsum of abdomen, except as already stated, clothed with appressed black hairs; venter ochraceous-buff (last two segments mouse-grey), speckled here and there with clove-brown or mouse-grey, and clothed with short, appressed, glistening, cream-buff-coloured hair. *Wings* conspicuously broader across centre of basal and axillary cells than at distal extremity, faintly tinged with drab, extreme base, third costal cell, and veins or portions of veins bounding distal extremities of basal cells suffused with light mummy-brown, second costal cell light raw-umber-coloured. *Squamae* cream-buff. *Halteres* light sepia-coloured. *Legs*: front and middle coxae clove-brown, grey pollinose, clothed with whitish hair, which is especially long and dense on front pair, hind coxae dark grey in front, greyish-buff posteriorly, clothed with whitish hair; front femora, except extreme tips, upper surface of middle femora, and extreme base and distal extremities of middle and hind femora, also except extreme tips, dark brown, extreme tips of all femora buff, middle and hind femora except as already stated, ochraceous-buff, all femora clothed with whitish or yellowish-white hair; tibiae and tarsi dark brown or clove-brown, clothed with black hair, which on hind tibiae forms a fringe on inner and outer surfaces, anterior surface of front and middle tibiae, except at distal extremities, clothed with minute, appressed, glistening yellowish hairs.

NORTHERN RHODESIA: Feira District, 1911 (*E. A. Copeman*).

*Diatomineura lineatithorax*, which agrees with the following species in the shape of its wings, is by reason of its thoracic markings easily distinguishable from any of its African congeners known to the author.

## **Diatomineura penetrabilis**, sp. n.

♀.—Length (1 specimen) 18 mm.; width of head 5·4 mm.; width of front at vertex 1 mm.; distance from upper margin of occiput to anterior extremity of face 4·6 mm.; length of proboscis 15 mm.; length of wing 18·5 mm.

*Front and upper surface of face dusky yellowish pollinose, front clothed entirely with pale yellowish hair; dorsum of thorax dark olive-brown, dusky yellowish-grey pollinose, practically unicolorous, without conspicuous markings; tergite of first abdominal segment raw-sienna-coloured, with a greyish clove-brown median blotch at base; tergites of next three segments brownish tawny, each with paler hind border and an irregularly shaped, more or less transversely elongate, clove-brown or black median spot or blotch at base; tergites of last three segments clove-brown, their lateral borders and hind margins dull yellowish; wings conspicuously narrower at*

*distal extremity than across centre of basal and axillary cells, faintly tinged with brown (extreme base mummy-brown), veins or portions of veins forming distal boundary of basal cells faintly suffused with mummy-brown.*

*Head:* sides of face (except orbits, which are thickly clothed with dull yellowish pollen) clove-brown, greyish-pollinose, moderately shining but without sharply defined shining calli; jowls, basi-occipital region, and occiput whitish-grey pollinose (upper portion of posterior orbits yellowish-grey pollinose), jowls and basi-occipital region thickly clothed with whitish hair; *palpi* chestnut or burnt-sienna-coloured, proximal joint dark brown on outer side, clothed with whitish hair on under side as in foregoing species; *antennae* as in foregoing species. *Thorax*: three dark longitudinal stripes indistinctly visible on median third of dorsum in front of transverse suture, anterior border of dorsum also with two light grey flecks, representing vestiges of stripes; hairy covering of dorsum as in foregoing species; pleurae and pectus also as in foregoing species. *Abdomen*: greyish clove-brown median blotch on first tergite not quite reaching hind margin, of about same width as scutellum, from beneath which it protrudes; tergite of second segment with a small, median, greyish clove-brown or black spot at base, and with a raw-sienna-coloured hind border, which is much narrower in the centre than on each side, where it occupies at least the posterior half of the segment, the anterior margin of the hind border and the posterior margin of the anterior and darker portion of the segment being sinuate; pale hind borders of tergites of third and fourth segments much less deep than hind border of tergite of second segment, and straight or nearly so, being only slightly deeper on posterior angles than in centre; when abdomen is viewed at a low angle from behind, second and three following tergites each exhibit a large, dull greyish pollinose median triangle, base of which rests on hind margin, while its apex, at least in case of third and two following tergites, extends to front margin of segment or nearly so; on third, fourth, and fifth segments greyish pollinose covering forming median triangle also extends outwards along hind border; tergites of sixth and seventh segments, except lateral borders and hind margins, entirely greyish pollinose; tergite of first segment clothed with ochreous or pale yellowish hair, except at base immediately adjacent to dark median patch where hair is black; following tergites clothed on their darker portions with short black hair, and elsewhere with ochreous, pale yellowish, or whitish hair (pale hair on sixth and seventh tergites confined to lateral margins and posterior angles, on fifth tergite pale hair absent from middle third of hind border); venter ochraceous-buff (last two scutes, except lateral borders and hind margins, more or less mouse-grey), clothed with appressed, glistening, ochreous or pale straw-yellow hair. *Wings*: second costal cell pale raw-sienna-coloured; veins for most part dark brown. *Squamae* buff. *Halteres* burnt-umber-coloured. *Legs*: coxae dark grey, clothed with pale yellowish-white hair; front femora dark brown (distal extremities reddish), clothed for most part with yellowish hair; middle and hind femora cinnamon-coloured (more or less dark brown at distal extremities, anterior surface of middle femora also largely dark brown), clothed with yellowish hair; front tibiae dark brown, more or less reddish at base, middle and hind tibiae burnt-umber-coloured, front tibiae (except tips on inside) and outer and posterior surfaces of middle and hind tibiae clothed with

minute, appressed, glistening, pale yellowish hair, hind tibiae also with inner and outer fringes of black hair ; tarsi dark brown or dark reddish-brown.

NORTHERN (NORTH-WESTERN) RHODESIA : Changa, 23.viii.1908, "in tent" (*R. E. Montgomery, M.R.C.V.S.* : presented by the Liverpool School of Tropical Medicine).

In the characteristic shape of its wings *Diatomineura penetrabilis* agrees with *D. lineatithorax*, as has already been indicated at the end of the description of the latter (*vide supra*). Owing to the absence of distinct thoracic markings, however, *D. penetrabilis* cannot be mistaken for the species mentioned, while the regularly *banded* appearance of the abdomen (particularly noticeable when the insect is viewed obliquely from the side, and due in large measure to the contrast between the pale-haired hind borders of the second, third, and fourth tergites, and the black-haired brownish-tawny portions of these segments) affords a means of distinction from any of the other African species of *Diatomineura* with which confusion could possibly arise.

### Diatomineura hastata, sp. n.

♀.—Length (1 specimen) 16 mm. ; width of head 5 mm. ; width of front at vertex 1 mm. ; distance from upper margin of occiput to anterior extremity of face 4 mm. ; length of wing 15·8 mm.

*Front raw-sienna-coloured pollinose, paler anteriorly, where there is an acicular, clove-brown, median, longitudinal streak, with its upper half grooved ; base of each antenna connected with eye on corresponding side by an oblique, mummy-brown stripe ; third joint of antennae ochraceous-rufous ; face with a shining clove-brown or black callus below antenna on each side ; dorsum of thorax dark olive-brown, a pair of indistinct admedian stripes dull yellowish-brown, lateral margins paler ; dorsum of abdomen olive-coloured, first three segments each with a clove-brown median blotch at base, and with a large orange-ochraceous area on each side ; wings pale sepia-coloured, not noticeably broader across middle of basal and axillary cells, hind margin being nearly parallel to costa ; legs cinnamon-rufous.*

*Head :* front sparsely clothed with minute, yellowish hairs ; face in front of orbits dark brown on each side, clove-brown or black above, thinly covered with grey pollen except on shining calli ; jowls, basi-occipital region, and occiput light smoke-grey, jowls and basi-occipital region thickly clothed with whitish hair ; *palpi* ochraceous-rufous ; *proboscis* more than 6·5 mm. in length (distal portion missing in case of type) ; first and second joints of *antennae* ochraceous-buff, greyish pollinose and clothed with minute black hairs, *first joint but little longer than* (*less than twice as long as*) *second.* *Thorax :* indistinct yellowish-brown admedian stripes on dorsum fairly broad, separated anteriorly by a narrow dark streak, behind which the stripes become more or less fused together according to angle at which they are viewed ; transverse suture on each side filled by an offshoot from corresponding admedian stripe ; humeral calli dusky cinnamon-rufous ; lateral borders of dorsum behind humeral calli yellowish-grey pollinose, clothed above base of wings and on under surface of anterior portion of postalar calli with a fringe of bright yellowish-white hair ; dorsum of main portion of thorax clothed anteriorly with minute, upstanding, yellowish hairs, and posteriorly with similar blackish hairs, the hair at each extremity being somewhat longer than

elsewhere; dorsum of scutellum clothed with blackish hair, and exhibiting a deep hind border (narrowing to each basal angle) of olive-grey pollen; pleurae and pectus olive-brown, covered with grey pollen and clothed with yellowish hair. *Abdomen:* clove-brown median blotch on tergite of first segment as wide as scutellum, almost reaching hind margin of segment but its posterior angles rounded off or concealed by yellowish-grey pollen; clove-brown median blotch on second tergite quadrate, extending from base to a little beyond middle, its posterior margin indented by apex of a dull and ill-defined olive-pollinose median triangle resting on hind margin of segment; tergite of third segment with a transversely elongate clove-brown median blotch at base, rather wider but less deep than blotch on second segment (occupying about centre third but not reaching to middle of segment), with its hind margin indented by apex of an olive-pollinose triangle, resting on hind margin and similar to but larger than triangle on second segment; *on tergites of first three segments* clove-brown blotches and olive-pollinose triangles together form *a broad, dark, median longitudinal stripe,* with concave sides; lateral margins of tergites of second and third segments somewhat infuscated (irregularly speckled with blackish grey); hind borders of tergites of third and following segments yellowish grey pollinose, lateral borders of fourth and following tergites orange-ochraceous; dorsum clothed partly with minute, appressed black hairs (mainly confined to last four segments and to dark median area or longitudinal stripe on first three segments), partly with glistening pale yellowish hairs; orange-ochraceous areas on first two segments clothed with pale yellowish hairs (longer as usual on posterior angles of first segment), lateral extremities of following segments also clothed with pale yellowish hairs, which likewise clothe each extremity of hind borders of these segments; anterior portion of orange-ochraceous areas on third segment clothed with black hairs; venter cream-buff, irregularly speckled here and there with dusky grey, and clothed with minute, appressed, glistening, cream-buff-coloured hairs. *Wings:* costa mummy-brown, first longitudinal vein cinnamon-rufous, other veins tawny. *Squamae* cream-buff. *Halteres:* stalks ochraceous-rufous, knobs fawn-coloured. *Legs:* coxae greyish clove-brown, front pair clothed with black hair mixed with whitish hair; femora clothed partly with black, partly with yellowish hairs, upper and anterior surfaces of hind femora clothed with black hairs; front and middle tibiae clothed with minute, glistening, ochreous hairs, hind tibiae clothed with black hairs; upper surface of front tarsi clothed partly with minute black hairs, partly with minute ochraceous hairs, upper surface of middle tarsi clothed with minute black hairs (hind tarsi wanting in case of type); tips of last four joints of front and middle tarsi dark brown.

PORTUGUESE EAST AFRICA, 1908 (*Dr. W. W. Woolliscroft:* presented by the London School of Tropical Medicine, per Lieut.-Col. Alcock, C.I.E., F.R.S.).

From *Diatomineura* (*Pangonia*) *rondanii*, Bertoloni (*Mem. Accad. Sc. Bologna*, T. xii, 1861, p. 56, fig. 8), which was described from a ♀ from Inyambane, *D. hastata* is distinguishable *inter alia* by the presence of the dark median stripe on the proximal portion of the abdomen. The dark and shining facial calli, shorter first antennal joint, ochraceous-rufous third joint, and redder legs of the species just described will serve to distinguish it from the foregoing species.

## *TABANINAE.*

### Genus Haematopota, Mg.

**Haematopota grahami,** sp. n. (fig. 1).

♀.—Length (13 specimens) 8·6 to 12·5 mm.; width of head 3 to 4 mm.; width of front at vertex just under 1 mm. to 1·2 mm.; length of wing 8·5 to 10·6 mm.

*Dark brown species, allied to and resembling* H. bullatifrons, *Austen,* but distinguishable at once,* inter alia, *by the hind tibiae being less expanded and, instead of exhibiting a pair of narrow, buff-coloured bands, having a single, much deeper, creamy-white band close to the base.—Front yellowish-grey pollinose, decidedly narrower than that of* H. bullatifrons; *frontal callus dark brown, extending practically from eye to eye; dorsum of thorax dark sepia-coloured, with grey markings as shown in* fig. 1, *dorsum of scutellum, except hind border, yellowish smoke-grey; dorsum of abdomen dark brown, with narrow grey hind borders to the segments, hind border of second segment usually somewhat deeper than remainder,*

Fig. 1.—*Haematopota grahami*, Austen, ♀. × 4.

*and in middle line expanded into a narrow, forwardly directed triangle, dorsal scutes of fifth and two following segments sometimes each bearing on its anterior half a pair of small, elongate, grey spots, resting on front margin of segment; wings dark*

* For this Northern Nigerian species Baron J. M. R. Surcouf, of the Muséum National D'Histoire Naturelle, Paris, recently proposed to found a new genus, which he was good enough to designate *Austenia* (Bull. Mus. Nat. D'Hist. Nat., 1909 (not published until 1910), p. 454). In proposing a generic separation in the case of *Haemotopota bullatifrons*, M. Surcouf relied upon the shape and other characters of the frontal callus, on the presence of fringes of long hair on the femora, and on the shape of the hind tibiae in this species; in the same paper the author in question, on the basis of characters presented by the antennae, proposed a new genus named *Potisa* for certain Oriental species, the genotype in this case being *Haemotopota pachycera*, Big., which occurs in Cambodia and Siam. In the opinion of the present writer, however, no valid division of the genus *Haematopota*, at any rate into categories higher than groups or subgenera, is possible, since, although within the limits of the genus great differences exist in the shape of the frontal callus, antennae, front and hind tibiae, etc., it would be difficult to find two species showing identical differences from the genotype, yet all are united by the well-known, highly characteristic, and distinctive wing-markings, as well as by a general *facies*.

*sepia-coloured, with pale markings as shown in* fig. 1 ; *front and hind legs clove-brown, middle legs dark brown (middle femora mouse-grey proximally, and with a broad, greyish, cream-buff band before distal extremity), front tibiae banded like hind tibiae, middle tibiae each with a pair of cream-buff or cream-coloured bands, varying in depth in different individuals, and sometimes occupying greater part of joint.*

*Head:* basi-occipital region, jowls, and lower part of face light grey, clothed with whitish hair, sides of face often with brownish hair in front ; occiput smoke grey ; *front* relatively rather narrow at vertex, somewhat broader anteriorly, vertex bearing a large, deltoid or cordate, dark sepia-coloured median spot, often narrowly divided in middle line ; median frontal spot if present small and inconspicuous, in contact with anterior extremity of spot on vertex, lateral frontal spots more or less oval, narrowly separated from or in contact with eyes ; *frontal callus* roughly semi-oval in shape, its curved upper margin produced in middle line into a small, upwardly directed angle, its straight lower margin with median portion, *i.e.*, part between antennae, descending somewhat lower than remainder, so that lower edge of callus is slightly excavated above each antenna, each lateral extremity of callus separated from eye on that side only by an exceedingly narrow pollinose line ; as in *H. bullatifrons*, Austen, and also in following species, a large clove-brown or black spot below and in contact with lower inner angle of each eye, a smaller median quadrate spot of similar colour between and above bases of antennae, in contact with median downward prolongation of lower edge of callus, and below and between antennae, only narrowly separated from or in some specimens apparently fused with median clove-brown or black spot just mentioned, a similarly coloured, transversely elongate spot ; *palpi* drab-grey or smoke-grey, clothed with glistening whitish or yellowish-white hair, distal portion of terminal joint more or less dark brown on outer side and clothed with minute blackish hairs, some blackish hairs also present on proximal portion of same joint, terminal joint elongate, but little or only moderately expanded at base ; first joint of *antennae* either shining raw-umber-coloured, except upper surface of distal extremity, which is shining dark brown, or shining dark brown, except inner surface of proximal three-fourths, which is shining raw-umber-coloured ; first joint of antennae, which is clothed with minute black hairs, elongate (longer than in either *H. bullatifrons* or the following species), and roughly cylindrical-ovate in outline, its distal two-thirds being moderately swollen, second and third joints dark brown (annulate portion of third joint clove-brown), third joint viewed from side narrow and elongate, its proximal portion but little wider at base. *Thorax:* anterior portion of dorsum with a pair of narrow, longitudinal, grey stripes, commencing on front border and terminating in or more or less indistinctly connected with a pair of grey sagittate spots, situate just behind inner extremities of lateral halves of transverse suture, lateral margins of dorsum and usual pair of bluntly crescentic marks on hind margin of main portion also grey ; dorsum (including scutellum) thinly clothed with short, pale yellowish hair, which on main portion of dorsum is mixed with minute blackish hairs ; pleurae and pectus light smoke-grey, clothed with whitish hair, mesopleurae with upper margins and a large blotch at lower extremity, sending out an offshoot on to sternopleurae, sepia-coloured. *Abdomen:* extreme base of tergite of second segment in most cases narrowly

grey, sometimes interrupted in middle line, posterior angles of tergite of first segment and lateral extremities of tergite of second (not always visible from above) also grey ; dorsum clothed with minute, appressed, dark brown hairs, except on grey hind borders, etc., which are clothed with whitish hair, posterior margin of first tergite sometimes with a few yellowish hairs on each side of middle line ; venter partly grey, partly dark brown, ventral scutes of first three (visible) segments grey, except anterior border of third segment, a quadrate median blotch on this segment, starting from base but not quite reaching hind margin, and a small and not sharply defined median patch on second segment, which are dark brown or brownish ; ventral scutes of four following segments dark brown, hind margins and posterior angles of fourth to sixth segments inclusive grey, hind margin of ventral scute of seventh segment also sometimes grey ; ventral scutes of second to fourth segments inclusive, and grey areas of two following ventral scutes clothed with appressed glistening whitish hairs, hind margin of ventral scute of last segment clothed with whitish or yellowish hair, ventral scutes of last three segments, except as stated, clothed with dark brown or blackish hair. *Wings:* pale markings on proximal side of stigma, especially towards costa, slightly tinged with cream-buff; *stigma* dark brown, elongate (usually distinctly longer than in *H. bullatifrons*) and conspicuous, with a large and more or less quadrate, dark sepia-coloured area below it, as shown in fig. 1 ; discal cell with two pale marks (sometimes connected or partly fused together) in its proximal extremity, and a couple of small pale spots, one more or less above the other and usually separate, at or near commencement of its distal third ; a more or less indistinct pale mark usually present in extreme apex of wing, at distal extremity of second submarginal cell, beyond ordinary sinuous mark, which starts from costa at distal extremity of first submarginal cell and terminates abruptly soon after crossing anterior branch of third longitudinal vein. *Squamae* dark sepia-coloured. *Halteres:* knobs sepia-coloured, paler (more or less cream-buff) at tips, stalks buff or cream-buff, entire halteres occasionally cream-buff, except base of knobs, which is slightly brownish. *Legs* clothed with black hair, except pale bands on tibiae which are clothed with glistening whitish hair ; whitish hair is also present on front and hind coxae (in case of front coxae sometimes clothing whole of anterior surface, sometimes confined to a grey band at base), on proximal three-fourths of middle femora (on under side of pale area on which it forms a long, fine fringe), and occasionally mixed with the black hairs on anterior surface of proximal half of hind femora ; upper and under surfaces of front femora and of distal halves of hind femora, and under surface of distal extremities of middle femora fringed with black hair, coarser and denser than elsewhere at distal extremities of hind femora ; front tibiae beyond pale band moderately swollen, outer surface of hind tibiae beyond pale band with a dense and conspicuous fringe of black hair, causing these tibiae on a cursory inspection to appear swollen also ; first joint of middle and hind tarsi usually paler (more or less buff or cream-buff) at base.

ASHANTI and SIERRA LEONE PROTECTORATE : type from Obuasi, Ashanti, 13. vi. 1907, "caught on boy's arm in bush-path ; two para-types from Obuasi—2. x. 1907, "caught in bush-path, 10 a.m.," and 6. xi. 1907, "caught in bush, 3 p.m." ; a third para-type from Kumasi, Ashanti, 19. x. 1907, "caught on arm

in bush-path, 10 a.m.": all the foregoing taken and presented to the British Museum (Natural History) by *Dr. W. M. Graham, W.A.M.S.* Two females from West Ashanti have also been examined—one from Tekerri, 24. v. 1911 (*T. E. Fell:* in possession of the Entomological Research Committee), the other from Sunyani Station, July, 1911 (*Dr. W. M. Wade, W.A.M.S.:* presented to the British Museum by the Entomological Research Committee). A field-note by Dr. Graham states that in Ashanti this species is "found only in thick forest." From the Sierra Leone Protectorate the Museum possesses the following examples, taken and presented by *Major A. Pearse, R.A.M.C.:*—two specimens from Gola Forest, 11. iii. 1909; four specimens captured between Mogbaima and Dombolo, 18. iii. 1909; one specimen from Dombolo, "on an elephant," 23. iii. 1909.

As regards differences between *Haematopota grahami* and *H. bullatifrons*, Austen, in addition to the distinctive characters upon which stress has already been laid, attention in the case of the present species may be directed to the much greater width of the frontal callus, which is almost in contact with, instead of "widely separated from", the eyes, the greater length and different coloration of the first joint of the antennae, and the much less extensive development of the grey markings on the main portion of the dorsum of the thorax. From the following species, which may be regarded as in some respects occupying an intermediate position between *Haematopota grahami* and *H. bullatifrons*, *H. grahami* may be distinguished by the above-mentioned characters in the frontal callus and first joint of the antennae, by the absence of a third (median) grey stripe on the dorsum of the thorax, the greater extent of the grey area on the scutellum, and, in the wing, by the greater length of the stigma and by the sinuous mark near the apex being interrupted before reaching the middle of the second submarginal cell.

## **Haematopota daveyi**, sp. n.

♀.—Length (2 specimens), 11 to 12·4 mm.; width of head, 3·8 to 4·2 mm.; width of front at vertex, 1·25 to 1·4 mm.; length of wing, 9·5 to 10·25 mm.

*Large or moderately large, dark-coloured species, closely allied to, and in some respects intermediate between, the foregoing species and* H. bullatifrons *Austen.—Head and all cephalic structures and markings practically as in* H. bullatifrons, *though interval between each lateral extremity of frontal callus and corresponding eye is narrower; dorsum of thorax dark brown with grey markings, scutellum with a large grey spot entirely surrounded with brown, either in centre of disc or extending closer to posterior than to anterior margin; dorsum of abdomen clove-brown, with conspicuous light grey hind borders to all segments, as well as other light grey markings; wings sepia-coloured, light markings agreeing generally with those on wings of* H. bullatifrons, *but apical sinuous mark sometimes interrupted or nearly so in middle of second submarginal cell, and median rosette and markings in discal cell as in foregoing species; legs as in foregoing species, except that proximal two-thirds of anterior surface of front femora, and proximal three-fourths of hind femora are grey and clothed, for most part at least, with whitish hair, while fringe of hair on outer side of hind tibiae is, if anything, somewhat longer, and pale area on first joint of hind tarsi is lighter in colour and more extensive.*

*Head:* upper portion of front with a dark sepia-coloured, V-shaped, median mark, extending from vertex to median frontal spot, with which its apex is in contact; in front of this is a less distinct, brownish, sinuous, transverse mark, shaped something like a flattened Ω, with extremities expanded into rounded spots and narrowly separated from the eyes; median frontal spot small and inconspicuous, lateral frontal spots large, not in contact with eyes, ovate but with their anterior margins excavated; *frontal callus* shining dark brown, semi-oval, its upper margin curved, its lower margin produced downwards in centre as in *H. bullatifrons* and foregoing species, its outer extremity on each side terminating at a point rather beyond half way between level of outer edge of proximal joint of antenna and inner margin of eye; clove-brown or black spots, on level with antennae, as in foregoing species or *H. bullatifrons; palpi* smoke-grey, clothed with whitish hair, terminal joint fairly large, moderately expanded at base, its distal extremity on outer side darker and clothed with minute black hairs as well as occasionally with some whitish hairs; *antennae* as in *H. bullatifrons. Thorax:* grey markings on main portion of dorsum resembling those exhibited by *H. bullatifrons* but less fully developed, the admedian stripes being more or less interrupted beyond the transverse suture, while the forwardly directed prolongations from the outer ends of the crescentic marks on the hind margin are only faintly indicated, and the median stripe is broadly interrupted on a level with the transverse suture, and is again but sometimes less distinctly interrupted before reaching the hind margin; hairy covering of dorsum as in foregoing species; pleurae and pectus light grey and clothed with whitish hair. *Abdomen* agreeing generally with that of *H. bullatifrons;* tergite of second segment with its grey hind border sometimes produced into a large, median, forwardly directed triangle, apex of which rests on hind margin of previous tergite; four following tergites each with (at least a vestige of) a grey, median, longitudinal stripe, which in case of sixth tergite is incomplete, and, commencing on front margin, does not extend beyond middle of segment; tergites of last three segments each with a pair of elongate, grey, admedian spots, resting on front margin; lateral extremities of first three tergites light grey; dorsum clothed with blackish hair, except hind borders and sides of segments, which are clothed with whitish hair; venter light grey and clothed with minute, appressed, yellowish hairs, except last segment and a large, median blotch (resting on front margin but not quite reaching hind border) on each of the two preceding segments, which are clove-brown and clothed, at least for most part, with black or blackish hair. *Wings:* stigma dark brown, decidedly shorter than in case of *H. grahami;* median rosette broken up into dots, as in latter species. *Squamae* light sepia-coloured. *Halteres:* knobs cream-coloured, brownish fawn-coloured at base above, stalks cream-buff. *Legs:* proximal two-thirds or rather more than proximal half of first joint of hind tarsi buff.

NYASALAND PROTECTORATE: type from Mpenya, Central Angoniland, 1. ii. 1910 (*Dr. J. B. Davey*); a second example from Fort Johnston, South Nyasa, 2,000 ft., 24. iii. 1910 (*Dr. A. H. H. Barclay*): both specimens presented to the British Museum (Natural History) by the Entomological Research Committee.

The author has much pleasure in associating with this species the name of Dr. J. B. Davey, an energetic and careful collector, who has done much to extend our knowledge of the blood-sucking flies of Nyasaland.

### **Haematopota rubens**, sp. n. (fig. 2).

♀.—Length (28 specimens) 8·5 to 10·6 mm.; width of head 3 to 3·75 mm.; width of front at vertex 1 to just over 1 mm.; length of wing 7·4 to 9·5 mm.

*Prettily-coloured species, with dark brown, grey-striped thorax, uniformly light grey scutellum, and abdomen cinnamon-rufous or brownish cinnamon-rufous above, with last three segments dark brown, paler (orange-ochraceous, orange-buff, or yellowish-grey) hind borders to all segments, and paired pale (orange-buff or grey) spots as shown in* fig. 2, *those on last tergite being often fused together; wings drab or drab-grey, with conspicuous dark brown stigma, and comparatively coarse whitish markings, as shown in* fig. 2.

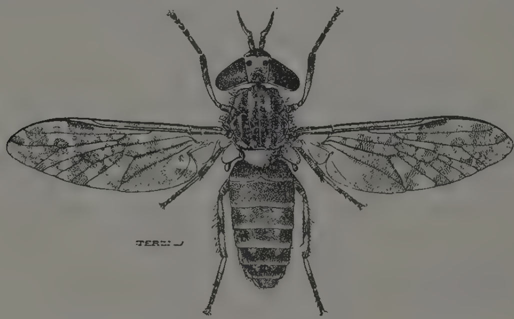

Fig. 2.—*Haematopota rubens*, Austen, ♀. × 4.

*Head: front* of moderate width, yellowish-grey, with a pair of dark sepia-coloured admedian spots on vertex, more or less triangular in outline, and either narrowly separate or to a greater or less extent fused together; median frontal spot small and inconspicuous, lateral frontal spots likewise not very large, narrowly separate from eyes; between dark spots on vertex and upper margin of frontal callus the front, except a narrow border along inner edge of each eye and the area immediately surrounding the median and each lateral frontal spot, is dusky (mouse-grey); *frontal callus* dull yellowish horn-coloured, of moderate depth, transversely oblong, extending from eye to eye, with its upper angles rounded off, and its upper margin either more or less uniformly curved or somewhat angulate in middle line; below and in contact with lower edge of frontal callus is a small dark brown median spot; face, jowls, and basi-occipital region light grey, occiput smoke-grey, a small dark brown spot usually visible below each antenna and on same level a similarly coloured, transversely elongate fleck adjacent to lower inner margin of each eye; jowls and basi-occipital region sparsely clothed with short, whitish hair; *palpi* isabella-coloured, proximal joint clothed with whitish hair, terminal joint clothed on outer side with minute, appressed, black hairs, and with some longer, pale yellowish hairs on under

surface of proximal portion; first joint of *antennae* pale ochreous, clothed like second joint with minute black hairs, first joint of moderate length, expanding from base to distal extremity when viewed from side, cylindrical (narrower at base) and appearing moderately stout, though not actually swollen, when seen from above, upper distal angle of second joint moderately produced, third joint cinnamon-coloured or brownish (annulate portion often dark brown), expanded portion as viewed from side varying in breadth in different individuals, but with its upper margin usually more or less angulate at a point one-third of its length from base; from this point the expanded portion of the third joint, which is here at its broadest, tapers more or less rapidly to its distal extremity. *Thorax*: dorsum with grey markings as shown in fig. 2, its anterior surface also grey; short hairs thinly covering dorsum (including scutellum) yellowish, mixed, except on scutellum, with darker hairs; pleurae and pectus whitish-grey or smoke-grey, clothed with whitish hair. *Abdomen*: pale spots on dorsum not present on first segment, and often indistinct on second, but on subsequent segments clearly visible, those on last two or last three segments grey; dorsum—except lateral margins and hind borders of segments, which are clothed with yellowish or ochreous hairs—clothed with minute, appressed, blackish hairs; venter buff, pinkish-buff, or ochraceous-buff, light greyish pollinose, penultimate and antepenultimate segments usually more or less mouse-grey, last segment greyish clove-brown, hind borders of second and following segments cream-buff, last segment (except hind margin and lateral extremities) clothed as usual with coarse, erect, black hair, remainder of ventral surface clothed with minute, appressed, yellowish hair, hind margin and lateral extremities of ventral scute of last segment also clothed with yellowish hair. *Wings*: the two whitish marks shown in fig. 2 crossing the discal cell often fused together, but on the other hand sometimes wider apart than in the specimen illustrated. *Squamae* isabella-coloured, borders darker. *Halteres*: knobs cream-buff or buff, usually more or less brownish above and below, at least at base, stalks cream-coloured. *Legs*: front coxae buff, greyish pollinose, middle and hind coxae smoke-grey, all coxae clothed with glistening whitish hair, front pair also with some black hairs on distal two-thirds of anterior surface; femora buff, front pair sometimes more or less mouse-grey, middle and hind pairs often greyish at base; front femora clothed mainly with minute black hairs, but proximal portion of under surface clothed with glistening whitish hairs, some whitish hairs also present on posterior surface, middle and hind femora clothed with glistening whitish hairs, with which on distal portion of their upper surfaces minute black hairs are intermingled; front tibiae not swollen, distal two-thirds or rather less clove-brown and clothed with minute black hairs, with which, at least on posterior and under surfaces, except at distal extremity, minute, glistening yellowish-white hairs are occasionally intermixed; extreme base of front tibiae isabella-coloured and clothed with minute black hairs; portion of front tibiae between isabella-coloured base and clove-brown distal extremity cream-coloured, clothed with minute, appressed, glistening yellowish-white hairs; middle and hind tibiae each with two pale (cream-buff) bands, as shown in fig. 2, pale bands clothed with yellowish hair, middle and hind tibiae clothed elsewhere with black hair, hind tibiae not incrassate; front tarsi clove-brown, middle and hind tarsi mummy-brown, extreme base of first joint of middle tarsi and proximal

two-thirds or three-fourths of first joint of hind tarsi cream-buff, second, third, and fourth joints of hind tarsi also cream-buff at base.

NYASALAND PROTECTORATE; NORTHERN RHODESIA; SOUTHERN RHODESIA. Type and one other specimen (para-type) from Makande, R. Lilongwe, Nyasaland Protectorate, 1,800 ft., 26, 28. i. 1911 (*Dr. Meredith Sanderson*: presented by the Entomological Research Committee). Additional material as follows.—NYASALAND PROTECTORATE: three specimens from Mpenya, Central Angoniland, 1. ii. 1910 (*Dr. J. B. Davey*); two specimens from Fort Johnston, South Nyasa, 26, 28. ii. 1910, in "goat kraal" and "sheep kraal" respectively (*Dr. A. H. H. Barclay*); two specimens from Ncheu, 18. i. 1911 (*Dr. J. E. S. Old*: presented, like all the foregoing, by the Entomological Research Committee); one specimen from Nkudzi, February, 1910 (*H. N. Tate*). NORTHERN RHODESIA: one specimen from Petauke, Luangwa Valley, 2,400 ft., 1. i. 1908, and one from the Upper Luangwa Valley, between 1,800 and 2,000 ft., 24. iii. 1908 (*S. A. Neave*); one specimen from Mangandwe Stream and another from Jani, 9 and 11. ii. 1911 (the late *O. C. Silverlock*: presented by the British South Africa Company and Mr. Silverlock's relatives); two specimens from Feira District, 1911 (*E. A. Copeman*); three specimens from Nawalia (two of them taken "on kudu"), January, 1912 (*Ll. Lloyd*: presented by the Entomological Research Committee). SOUTHERN RHODESIA: one specimen from Lomagundi, February, 1912 (received from R. W. Jack). The following material in possession of the Entomological Research Committee has also been examined.—From the Nyasaland Protectorate:—three specimens collected by *Dr. J. B. Davey*, one specimen obtained by *Dr. A. H. H. Barclay*, and one collected by *Dr. J. E. S Old* (details in each case as already given); also one specimen from Fort Johnston, South Nyasa, February, 1910 (*S. A. Neave*). From Northern Rhodesia:—two specimens from Nawalia, January, 1912 (*Ll. Lloyd*).

The ruddy coloration of the proximal two-thirds of the dorsal surface of the abdomen in this species is very noticeable—at least in dried specimens of the female sex, and the combination of characters included in the diagnosis at the commencement of the above description renders females of *Haematopota rubens* readily distinguishable from those of any other Ethiopian *Haematopota* at present described.

### **Haematopota beringeri**, sp. n. (fig. 3).

♀.—Length (21 specimens) 8 to 10·2 mm., width of head 2 to 2·8 mm.; width of front at vertex 0·75 to 1·2 mm.; length of wing 7·2 to 9·4 mm.

*Narrow-bodied, elongate species, with dorsum of thorax mummy-brown, conspicuously striped with cream-buff, and that of abdomen cinnamon-coloured, darker at distal extremity, and with a more or less distinct, pale (yellowish-grey), median, longitudinal stripe, commencing on second segment and defined by a narrow, dark brown or brownish area on each side of and immediately adjacent to it; wings marked as shown in* fig. 3, *the border being sepia-coloured (narrower and deeper in tint between first and second longitudinal veins and costa than at apex or in its distal posterior portion), and the intervening area, from base of wing to fork of third*

*longitudinal vein, having a faint isabelline tint, but being without conspicuous markings (basal and anal cells totally devoid of markings); legs cinnamon-coloured, tibiae slender, without bands.*

*Head* yellowish-grey pollinose, jowls and basi-occipital region sparsely clothed with yellowish hair; vertex with usual pair of admedian, mummy-brown spots, in front of and in contact with which is a (frequently less distinct) mummy-brown or brownish, Y-shaped mark, the stem of which lies between the lateral frontal spots; median frontal spot usually wanting, but if present exceedingly small and inconspicuous, lateral frontal spots not in contact with eyes; *frontal callus* raw-umber- or yellowish-horn-coloured, of medium depth, extending from eye to eye, usually somewhat deeper at each lateral extremity than in middle, central portion of lower margin being somewhat excavated, upper margin straight or nearly so; in middle line immediately below and in contact with callus is a short, vertical, mummy-brown streak, while immediately below antennae is a narrow, transverse, mummy-brown band, extending from eye to eye, but interrupted on each side of central portion of face; *palpi* ochraceous-buff, clothed on

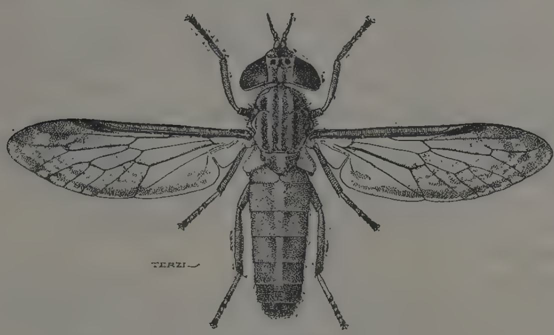


Fig. 3.—*Haematopota beringeri*, Austen, ♀. × 4.

outer side with blackish hair above, and below with ochraceous hair; first and second joints of *antennae* orange-buff, first joint not elongate but somewhat swollen on inner side, angles of second joint not produced, third joint as viewed from side narrow and elongate, expanded portion ochraceous-rufous, without prominent angle on upper margin, annulate portion clove-brown. *Thorax*: dorsum marked, as shown in fig. 3, with complete longitudinal stripes, alternately cream-buff and mummy-brown, sides of dorsum edged with mummy-brown from humeral callus to posterior branch of transverse suture, a short mummy-brown streak also present above base of each wing, between postalar callus and posterior branch of transverse suture; pleurae and pectus cream-buff, thinly clothed with yellowish hair, dorsum clothed with minute, appressed, ochreous hairs; *scutellum*, except two elongate, mummy-brown spots on dorsum, cream-buff. *Abdomen*: tergites of last three segments more or less brownish-olive, those of second and following segments sometimes each with a pair of longitudinally elongate, yellowish-grey spots (scarcely noticeable except when abdomen is viewed at a low angle from behind), one of which is situate on each side of middle line,

between admedian dark brown or brownish area and lateral margin; lateral extremities of first (visible) tergite light grey, those of three following tergites also somewhat greyish; dorsum and venter clothed with minute, appressed, ochraceous or ochreous hairs; venter agreeing with dorsum in coloration, but without median stripe or paired spots. *Wings*: stigma dark brown, elongate and well-defined. *Squamae* isabella-coloured, borders cream-buff. *Halteres*: knobs seal-brown (distal border sometimes buff), stalks cream-buff.

GOLD COAST (NORTHERN TERRITORIES) and NORTHERN NIGERIA: type and 16 para-types from Kalande, Northern Territories, Gold Coast, 22. vii. 1910, "at water-hole" (*Dr. F. J. A. Beringer, W.A.M.S.*). The following are the localities and dates of capture of 68 additional examples of this species, which, like the typical series of specimens, were taken in the Northern Territories, Gold Coast, and presented to the National Collection by Dr. Beringer, whose name the author is glad to be able to associate with this unusually distinct-looking *Haematopota* (the figures in parentheses indicate the number of specimens):—(4) Dimbipe, (5) Bongwiripe, 19.vii.; (1) Bongwiri, 20.vii., "in bush"; (1) Girammahama, (1) Girambabina, 20.vii.; (15) Fadama, 20, 21.vii.; (1) Girambongwira, 21.vii.; (5) Serpriso, 23.vii.; (4) Kukulu Road, 24.vii.; (11) Kombi, 24.vii., 8.viii., "water side"; (2) Kalande, 25.vii., "water side"; (1) between Sissipi and Butuku, "in bush near stream," and (1) Butuku Village, 26.vii.; (2) near Jampari, 28.vii., "flowing water"; (2) Girambasana, 8.viii.; (7) swamp near Salaga, Tamale Road, 16.viii.; (6) swamp near Salaga, Tandy Road, 17.viii.1910. From Northern Nigeria the British Museum (Natural History) at present possesses but a single ♀ of *H. beringeri*,—taken two miles out of Lokoja, 16.vii.1911 (*Dr. E. A. Chartres, W.A.M.S.*: presented by the Entomological Research Committee).*

*Haematopota beringeri*, which belongs to the well-marked group of species including *H. denshamii*, Austen, *H. copemanii*, Austen, and others,† resembles in its very unusual coloration *H. fulva*, Austen,‡ a species met with as yet only in Benguella, Angola. From *Haematopota fulva*, however, *H. beringeri* is distinguishable without difficulty owing to its much more distinctly striped thorax, darker wing-stigma, and more slender front tibiae.

**Haematopota crudelis**, sp. n. (fig. 4).

♀.—Length (10 specimens) 8·4 to 9·6 mm.; width of head 3·2 to 3·5 mm.; width of front at vertex 0·8 to 1 mm; length of wing 7·75 to 8·8 mm.

*Medium-sized or rather small, blackish, pale-winged species, with body, wings, and legs marked as shown in* fig. 4.—*Dorsum of thorax clove-brown with light grey markings, that of abdomen blackish clove-brown or black with markings of somewhat darker grey; scutellum smoke-grey, with a brown or brownish blotch* (*sometimes so faint as to be scarcely distinguishable*) *on each lateral border near base.*

*Head*: *front*, except frontal spots and usual bifid, median, dark brown, deltoid blotch on vertex sometimes light grey, in other cases light grey area is confined

* [The Committee has also received two females taken between Daboya and Busunu, Northern Territories, Gold Coast, vii. 1912 (*C. Saunders*).—Ed.]

† *Cf.* Austen, Illustrations of African Blood-Sucking Flies, p. 126 (1909).

‡ *Cf.* Austen, *op. cit.*, p. 125, and Plate xi., fig. 84.

to lateral margins and immediate vicinity of frontal spots, remainder of front between frontal callus and blotch on vertex being dark brown or mouse-grey; all three frontal spots present, lateral frontal spots small, narrowly separated from eyes; front clothed partly with pale yellowish, partly with blackish hair, in both cases hairy covering of front very short; *frontal callus* clove-brown, extending from eye to eye, its lower margin perfectly straight, its upper margin rising to an angle in middle line; in some specimens the frontal callus is divided into two halves by a median, vertical, pollinose stripe, which in other instances (at least in pinned material available for examination) is represented merely by a small pollinose fleck, interrupting lower edge of callus in middle line; face, jowls, and basi-occipital region pearl-grey, clothed with glistening white hair, occiput grey, upper portion of face on each side next eye with a clove-brown fleck, which is often transversely elongate; *palpi* drab-grey, clothed with glistening white hair, which on distal two-thirds of outer surface of terminal joint, where ground-colour is usually darkish grey, is mixed with minute black hairs; first and second joints of *antennae* clove-brown or blackish, thinly clothed with greyish pollen,


Fig. 4.—*Haematopota crudelis*, Austen, ♀. × 4.

first joint paler (dusky cinnamon-rufous) at base, at least on inner side, cylindrical in shape (not incrassate) and of moderate length, upper distal angle of second joint but slightly produced, proximal three-fourths of under surface of first joint clothed with white or yellowish-white hair, second joint and remainder of first joint clothed with minute black hairs, expanded portion of third joint viewed from side truncate-lanceolate in outline, of moderate breadth, dark brown, sometimes paler (isabella-coloured) at extreme base, annulate portion of third joint clove-brown or black. *Thorax:* dorsum, including scutellum, clothed with short, appressed, yellowish or yellowish-white hair, lateral borders of dorsum smoke-grey, swelling occupying depression at each end of transverse suture clothed below with longer, outstanding, blackish hair; pleurae and pectus grey pollinose, clothed with white hair. *Abdomen:* lateral extremities of first six tergites grey, and clothed with minute, appressed, white hairs, hind borders of sixth and seventh tergites and lateral extremities of those of preceding tergites also clothed with white hair (hind margin of last tergite and extreme lateral margins of preceding tergites clothed with longer white hair), remainder of dorsum clothed with blackish hair, which on first five tergites is minute and appressed; venter, except

last segment, smoke-grey pollinose, and clothed with minute, appressed, yellowish or yellowish-white hairs, ventral scute of last segment, except hind margin, clove-brown and clothed as usual with coarse, erect, black hair, hind margins of all ventral scutes cream-coloured, hind margin of last ventral scute clothed with yellowish or yellowish-white hair. *Wings* drab-grey, appearing relatively pale when viewed against a light background; pale markings as seen in fig. 4, much broken up; *stigma* brown or dark brown, conspicuous. *Squamae* isabella-coloured, their borders sepia-coloured. *Halteres* waxen-white or cream-coloured. *Legs:* coxae grey, clothed with white or yellowish-white hair, distal extremities of front pair darker (greyish clove-brown) and clothed with blackish hair; femora greyish brown or greyish clove-brown (median portion of middle pair sometimes fawn-coloured), clothed for most part with white but also partly with black hair; front tibiae and tarsi black, former just beyond base with a conspicuous cream-coloured band, clothed with minute, appressed, glistening, silvery-white hairs, extreme base of front tibiae dark brown, front tibiae not actually incrassate but increasing slightly in width from just beyond base to commencement of distal fourth; middle and hind tibiae and tarsi dark brown, middle tibiae each with a pair of cream-coloured or cream-buff bands of approximately equal depth, hind tibiae each with a somewhat deeper band of same colour a little beyond base, and a narrower, less brightly coloured, and more or less incomplete cream-buff band on distal third; pale bands on middle and hind tibiae clothed with yellowish-white or yellowish hair (minute and appressed except on inner and outer margins of proximal band on hind tibiae, where it is longer and more outstanding), which on inner surface is also present on intervening area; first joint of both middle and hind tarsi usually paler (raw-umber-coloured) at base.

German East Africa: type and one para-type from the Ruaha Valley, North Uhehe District, 19.xii.1910 (*S. A. Neave*). Additional para-types as follows (all collected by Mr. *S. A. Neave*):—one from North Uhehe District, 15. xii. 1910; one from the foot of Kifulufulu Mountain, Iringa-Kilossa Road, Usangu District, 3,000 ft., 16 or 17. xii. 1910; six from South Usagara District, 22–24. xii. 1910. The whole of the foregoing specimens, with the exception of two of the para-types from South Usagara, which are retained by the Committee, have been presented to the British Museum (Natural History) by the Entomological Research Committee.

*Haematopota crudelis* is closely allied to *H. cruenta*, Austen (of which the type and only specimen at present known is from the Katanga District of the Congo Free State), to which it presents a somewhat deceptive resemblance in general appearance; the new species can, however, be distinguished from *H. cruenta* by the first joint of its antennae being considerably longer, by the greater development of the grey markings on the hind border of the main portion of the dorsum of the thorax, by the absence of a deep clove-brown edging to the scutellum, and by the knobs of its halteres being entirely white or cream-coloured, instead of seal-brown at the base above and below.

# A NEW SPECIES OF HIPPOBOSCA FROM NORTHERN RHODESIA.

By Ernest E. Austen.

(*Published by permission of the Trustees of the British Museum.*)

## **Hippobosca fulva**, sp. n.

♀.—Length (1 specimen) 3·5 mm.; width of head 1·4 mm.; width of front at vertex 0·6 mm.; length of wing 5 mm.

*Extremely small species: thorax (exclusive of scutellum) and abdomen deep tawny, thorax entirely devoid of markings; scutellum, except hind border, pale straw-yellow, with four relatively stout, ochraceous bristles on hind border on each side of middle line; wings nearly hyaline, faintly tinged with drab-grey but not at all infuscated, veins ochraceous; legs ochraceous or tawny ochraceous, without bands or other dark markings, except that extreme tips of femora are narrowly edged with dark brown, at least above.*

*Head:* triangular plate on vertex wax-yellow; sides of front ochraceous, anterior border of front raw-sienna-coloured, narrow; *frontal stripe* cinnamon-rufous; face yellowish-white, its lower edges fringed with black hairs, under surface of head clothed with Naples-yellow or pale yellowish hair; *palpi* dark brown; *antennae* tawny ochraceous. *Thorax:* short bristles or spines in front of base of each wing three in number, black, and arranged in a transverse row, longer hair or bristles on dorsum sparse and yellowish in colour; fine hair on pleurae and pectus pale yellowish; hind border of scutellum ochraceous or tawny ochraceous. *Abdomen* clothed with pale yellowish hair. *Wings:* costa (at least in typical example) dipping below first longitudinal vein between a point approximately on a level with commencement of distal fourth of first basal cell and end of first longitudinal vein; costa, except at base, bearing a single row of short bristles, arranged at more or less regular intervals; *third longitudinal vein straight* and *much closer to second longitudinal vein and costa* than in case of *H. capensis*, v. Olf., so that the submarginal cell is conspicuously narrower than in the species mentioned; neither anterior transverse vein nor adjacent portions of veins infuscated. *Halteres* ochraceous. *Legs:* front coxae, except at base, pale straw-yellow; hair and bristles for most part agreeing with ground-colour, two or three long bristles at tips of hind femora above, and short bristles at distal extremities of hind tibiae dark brown.

Northern (North-Eastern) Rhodesia: Nawalia, 21.ix,1911, on haartebeeste (*Alcelaphus lichtensteini*, Peters) (*Ll. Lloyd:* presented to the British Museum by the Entomological Research Committee).

The species described above cannot possibly be confused with any of its congeners previously known, and its discoverer is to be congratulated on having made so interesting an addition to the extremely limited number of recognised species of *Hippobosca.*

## COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen who have kindly presented collections of insects (received between 1st July and 30 September 1912):—

Dr. D. Alexander:—87 Culicidae, and 225 Culicid larvae; from Freetown, Sierra Leone.

Mr. T. J. Anderson:—142 Culicidae, 67 *Haematopota*, and 43 other Diptera; from Nairobi, British East Africa.

Mr. H. A. Ballou:—13 Coleoptera (economic) belonging to 2 species, and 9 larvae and pupae; from British West Indies.

Mr. John R. Bovell:—12 *Tiphia parallela* and numerous Eriophyid and Tarsonemid mites; from Barbados.

Mr. E. Brand:—3 *Tabanus*; from Malindi, British East Africa.

Dr. G. D. H. Carpenter:—4 Culicidae, 4 *Tabanus*, 1 *Stomoxys*, 1 Hippoboscid, 35 other Diptera, 6 Dipterous pupae, a number of Hymenoptera in spirit, 4 other Hymenoptera, a number of cocoons, 7 Coleoptera, 4 Coleopterous larvae, 5 Coleopterous pupae, 2 Planipennia, 2 Odonata, 10 Orthoptera, 8 Rhynchota, 11 Mallophaga, 40 Worms, 6 Leaches, and some Argulidae; from Uganda.

Dr. G. H. D. Chell:—26 Tabanidae, 6 *Glossina*, 7 *Stomoxys*, and 76 other Diptera, from Marsabit, British East Africa.

Dr. C. L. Chevallier:—6 Culicidae, 27 Tabanidae, 55 *Glossina*, 2 *Hippobosca*, 2 other Diptera, 4 Hymenoptera, 13 Moths, 1 Myrmeleonid, 1 Cicada, and 1 Scorpion; from Juba River, British East Africa.

Dr. Robert Drummond:—27 Tabanidae, 23 *Glossina morsitans*, 15 *Auchmeromyia*, 42 other Diptera, and 9 Hymenoptera; from Zomba, Nyasaland.

Dr. H. Lyndhurst Duke:—1 *Tabanus*, 13 *Stomoxys*, 1 *Ornithophila*; from Mpumu, Uganda.

Dr. Mercier Gamble:—4 Culicidae, 12 Simuliidae, 3 *Glossina palpalis*, 2 *Stomoxys*, 3 *Auchmeromyia*, 4 Cetoniidae, and 4 Coccidae; from Portuguese West Africa.

Dr. L. H. Gough:—3 Ephydridae, 18 other Diptera, 9 Hymenoptera, 2 Cocoons and 3 Larvae; from Cairo.

Mr. C. C. Gowdey:—3 *Chrysops*, 1 *Glossina*, 768 other Diptera, 832 Hymenoptera, 3913 Coleoptera, 3 Lepidoptera, 7 Ephemeridae, 841 Orthoptera, 18 Cimicidae, a number of Coccidae, 1643 other Rhynchota, 14 Anoplura, 47 Ticks, 2 Mites, 1 other Arachnid, 1 Centipede, and 1 Mollusc, from Uganda.

Mr. J. O. W. Hope:—5 Culicidae, 7 Coleoptera, 5 Ticks; from Marsabit, British East Africa.

Dr. A. Ingram:—61 Culicidae, 3 *Ceratopogon*, 2 *Tabanus secedens*, 9 *Glossina longipalpis*; from the Gold Coast.

Maj. H. Kelsall, R.A. :—1 *Tabanus*, 7 Hippoboscidae, 40 Mallophaga, 1 Tick, and 66 Mites ; from Sierra Leone.

Mr. Harold H. King :—7 *Lyperosia*, 21 *Phlebotomus*, 31 other Diptera, 19 Siphonaptera, 77 Hymenoptera, 1 Lepidopteron, 112 Coleoptera, 102 Rhynchota, and 14 Orthoptera ; from the Anglo-Egyptian Sudan.

Dr. J. McConaghy :—24 Culicidae, 6 Tabanidae, and 18 *Glossina palpalis* ; from Sierra Leone.

Dr. R. E. McConnell :—66 *Haematopota*, 3 *Glossina*, 4 *Auchmeromyia*, 2 Hippoboscidae, 7 other Diptera, 6 Siphonaptera, and 85 Ticks ; from Uganda.

Dr. J. W. Scott Macfie :—41 Culicidae, 203 *Tabanus*, 39 *Haematopota*, 1534 *Glossina*, 3 *Stomoxys*, 18 Hippoboscidae, 1584 other Diptera, a large number of Ants, 223 other Hymenoptera, 57 Coleoptera, 84 Lepidoptera, 7 Planipennia, 8 Orthoptera, 16 Odonata, 1 Termite, 46 Rhynchota, 2 Ticks, and 1 Chelifer ; from Ilorin Province, Northern Nigeria.

Dr. Bernard Moiser :—16 Culicidae, 60 *Glossina tachinoides* ; from North Bornu, N. Nigeria.

Dr. J. E. S. Old :—4 Coleoptera, 2 Hymenoptera, 4 Orthoptera, 3 Rhynchota, 1 Termite, 16 Mallophaga, 2 Ticks, 5 other Arachnida, 1 Centipede, and 3 tubes containing intestinal Worms ; from Nyasaland.

Dr. G. J. Pirie :—104 Culicidae, 7 *Tabanus*, 30 *Haematopota*, 49 *Glossina*, 5 *Stomoxys*, 11 *Lyperosia*, and 1 *Auchmeromyia* ; from Zaria Province, Northern Nigeria.

Dr. E. Powell :—9 *Tabanus*, 3 other Diptera ; from Sierra Leone.

Dr. Wm. J. Radford :—5 Culicidae, 9 *Tabanus*, 7 *Haematopota*, 5 *Glossina*, 4 *Stomoxys*, 1 *Auchmeromyia*, 10 other Diptera, 5 Hymenoptera, 1 Lepidopteron, 1 Orthopteron, 1 Tick, and 5 other Arachnida ; from British East Africa.

Miss Muriel Robertson :—93 Rhynchota, and 1 *Simulium* ; from Mpumu, Uganda.

Rev. K. St. Aubyn Rogers :—12 *Haematopota*, 4 other Diptera, 2 Hymenoptera, 1 Lepidopteron, 102 Coleoptera, 10 Orthoptera, 10 Rhynchota ; from Rabai, British East Africa.

Dr. Jas. J. Simpson :—148 Culicidae, and a large number of Culicid larvae, 94 *Tabanus*, 13 *Haematopota*, 2 *Chrysops*, 378 *Glossina*, 20 *Stomoxys*, 169 *Simulium*, 3 *Auchmeromyia*, 265 other Diptera, 282 Hymenoptera, 565 Coleoptera, 1246 Lepidoptera, 5 Planipennia, 7 Trichoptera, 196 Odonata, 220 Orthoptera, 6 Coccidae, 349 other Rhynchota, 40 Homopterous larvae, 6 Siphonaptera, 170 Ticks, 3 Mites, 3 other Arachnida, and a number of Tabanid Eggs ; from Sierra Leone.

Mr. F. J. T. Storrs :—93 Tabanidae, 6 *Glossina*, 9 *Stomoxys*, 1 *Auchmeromyia*, 14 other Diptera, and 1 Lepidopteron ; from Karonga, Nyasaland.

Dr. H. Swale :—41 Tabanidae, 3 *Auchmeromyia*, 1 *Cordylobia*, 25 other Diptera, 9 Coleoptera, 1 Moth, 6 Embiidae, 2 Orthoptera, 7 Rhynchota, and 3 Arachnida ; from Zambesi River, Portuguese East Africa.

Mr. F. W. Urich :—7 Diptera, and 10 pupa cases, 11 Hymenoptera, 106 Coleoptera, 7 Lepidoptera, and 5 Rhynchota ; from Trinidad.

Dr. C. A. Wiggins :—35 Culicidae, 17 Hymenoptera, 40 Coleoptera, 3 Lepidoptera, 2 Orthoptera, and 29 Rhynchota ; from Uganda.

Mr. F. C. Willcocks :—8 Diptera, and 15 Coleoptera ; from Cairo.

Dr. K. S. Wise :—155 Mallophaga and Anoplura, and 327 Siphonaptera ; from British Guiana.

Dr. J. Y. Wood :—20 *Tabanus*, and 84 *Glossina* ; from Sierra Leone.

# GENERAL INDEX.

*The numerals in heavy type indicate that the species to which they refer is figured.*

# INDEX TO NAMES OF PERSONS.

# INDEX TO PLANTS ATTACKED BY INSECTS.

# ERRATA.

P. 53, col. 2, delete "vexans, Mg. . . . 21."

P. 81, par. 2, line 1, for "Flies undoubtedly plays" read "Flies undoubtedly play."

P. 85, footnote, line 5, for "*Sargophaga*" read "*Sarcophaga*."

P. 110, for "Dr. W. L. Radford" read "Dr. W. J. Radford."

P. 170, line 6, for "Dr. R. W. S. Smythe" read "Dr. A. W. S. Smythe."

P. 212, footnote, line 11, for "Dr. W. Radford" read "Dr. W. J. Radford."

P. 223, table of species, for "*Tabanus biguttatus croceus*, Wied." read "*Tabanus biguttatus croceus*, Surc."

P. 225, for "Dr. W. J. D. Inness" read "Dr. W. D. Inness."

P. 226, for "Dr. E. C. Strathairn" read "Dr. G. C. Strathairn."

P. 301, line 24, for "Barrington" read "Harrington."

P. 315, for "*Cadicera nigrescens*, Ric." read "*Cadicera biclausa*, Lw."

P. 315, for "*Cordylobia anthrophaga*, Grünb." read "*Cordylobia anthropophaga*, Grünb."

P. 318, for "*Adersia oestroides*, Aust." read "*Adersia oestroides*, Karsch."

P. 322, for "*Haematopota ugandae*, Aust." read "*Haematopota ugandae*, Ric."

P. 366 (twice), for "*Phlebotomus duboscqui*" read "*Phlebotomus duboscqi*."

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